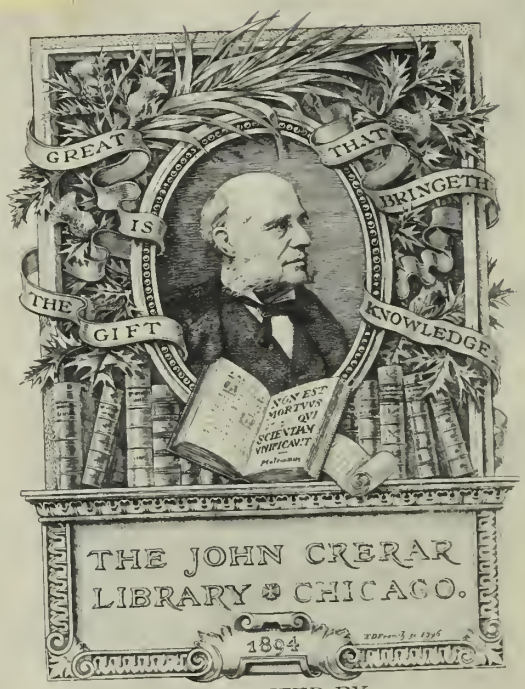
LIBRARY
OF THE
UNIVERSITY
OF ILLINOIS
C
C71mH
1912/14-1916/18



PRESENTED BY
Colorado School of Mines.

Digitized by the Internet Archive
in 2012 with funding from
University of Illinois Urbana-Champaign

http://archive.org/details/generalcatalog191218colo

SCHOOL OF MINES QUARTERLY

Vol. VII. No. 4.

Entered as second-class mail matter July 10, 1906, at the Post Office at Golden, Colorado, under the Act of Congress of July 16, 1894

THE
JOHN CRERAR
LIBRARY

The Experimental Ore Dressing and Metallurgical Plant. Colorado School of Mines.

Withdrawn

QUARTERLY

OF THE

COLORADO SCHOOL OF MINES

Vol. VII. No. 4

Catologue Edition

GOLDEN, COLORADO
1912-1914

C
C71mH

TABLE OF CONTENTS.

(For Complete Index see Page 141.)

	Page
College Calendar	9
Board of Trustees	11
Faculty	12, 13
Special Lecturers	14, 15, 16
History, Organization, Financial Support, and Location	17, 18, 19
Buildings	20, 21, 22
Laboratories and Equipment	23-34
Requirements for Admission	35-39
Departments of Instruction—	
Tabular Views	41-53
Mining	54-63
Metallurgy	64-74
Geology and Mineralogy	75-82
Civil Engineering	83-86
Mechanical Engineering	87-94
Electrical Engineering	95-97
Chemistry	98-107
Physics	108-109
Mathematics	110-113
English	114
Mining Law	115
Inspection Trips	116-123
General Information	124-131
Enrolment of Students	132
Index	141-144

Withdrawn
397643

COLLEGE CALENDAR.

1912.

November 28, Thursday.....	Thanksgiving Recess.
November 29, Friday.....	
November 30, Saturday.....	
December 23, Monday.....	Christmas Recess Begins.

1913.

January 4, Saturday.....	Christmas Recess Ends.
January 18, Saturday.....	First Semester Ends.
January 20, Monday.....	Second Semester Begins.
February 12, Wednesday.....	Lincoln's Birthday. (A Holiday).
February 22, Saturday.....	Washington's Birthday. (A Holiday).
May 23, Friday.....	Second Semester Ends. Commencement Exercises.
May 26, Monday.....	Summer Work in Surveying Begins.
July 5, Saturday.....	Summer Work in Surveying Ends.
July 14, Monday.....	Summer School Begins.
August 23, Saturday.....	Summer School Ends.
August 27, Wednesday.....	Examinations for entrance to the class of 1917, and re-examination of matriculated students.
August 28, Thursday.....	
August 29, Friday.....	
September 2, Tuesday.....	Opening of the first semester of the Academic year 1913-14.
November 27, Thursday.....	Thanksgiving Recess.
November 28, Friday.....	
November 29, Saturday.....	
December 22, Monday.....	Christmas Recess Begins.

1914.

January 3, Saturday.....	Christmas Recess Ends.
January 17, Saturday.....	First Semester Ends.
January 19, Monday.....	Second Semester Begins.
February 12, Thursday.....	Lincoln's Birthday. (A Holiday).
February 22, Sunday.....	Washington's Birthday.
February 23, Monday.....	(A Holiday).
May 22, Friday.....	Second Semester Ends. Commencement Exercises.

May 25, Monday	Summer Work in Surveying Begins.
July 3, Friday	Summer Work in Surveying Ends.
July 20, Monday	Summer School Begins.
August 29, Saturday	Summer School Ends.
September 2, Wednesday September 3, Thursday September 4, Friday	Examinations for entrance to the class of 1918 and re-examination of matriculated students.
September 8, Tuesday	Opening of the first semester of the Academic year 1914-15.

BOARD OF TRUSTEES.

FRANK BULKLEY, E. M., Denver, Colo.
President.
Term expires, 1913.

JAMES T. SMITH, Denver, Colo.
Secretary.
Term expires, 1913.

FREDERICK C. STEINHAUER, E. M., Denver, Colo.
Term expires, 1915.

WILLIAM J. BENNETT, Golden, Colo.
Term expires, 1915.

EDMOND C. van DIEST, E. M., Colorado Springs, Colo.
Term expires, 1915.

HARRY M. RUBEY, Woods-Rubey National Bank, Golden, Colo.
Treasurer.

The regular meetings of the Board of Trustees are held in Golden, at the School of Mines, on the second Thursday of each month.

FACULTY.

VICTOR CLIFTON ALDERSON, A. B., Sc. D.,
President.

PAUL MEYER, Ph. D.,
Professor Emeritus of Mathematics.

HORACE BUSHNELL PATTON, Ph. D.,
Professor of Geology and Mineralogy.

HERMAN FLECK, Nat. Sc. D.,
Professor of Chemistry.

FRANK WEISS TRAPHAGEN, Ph. D., F. C. S.,
Professor of Metallurgy.

CHARLES ROLAND BURGER, A. B.,
Professor of Mathematics.

LOUALLEN FREDERICK MILLER, A. M.,
Professor of Physics.

WILLIAM JONATHAN HAZARD, E. E.,
Professor of Electrical Engineering.

GEORGE WILLIAM SCHNEIDER, E. M., A. M.,
Professor of Mining.

RANSOM SMITH HAWLEY, B. S.,
Professor of Mechanical Engineering.

WILLIAM GEORGE HALDANE, B. S.,
Associate Professor of Metallurgy.

GURDON MONTAGUE BUTLER, E. M.,
Associate Professor of Geology and Mineralogy

CHARLES DARWIN TEST, B. M. E., A. C.,
Assistant Professor of Chemistry.

JOHN CHRISTIAN BAILAR, A. M.,
Assistant Professor of Chemistry.

GEORGE EULAS FOSTER SHERWOOD, A. B.,
Assistant Professor of Mathematics.
(On leave of absence for 1912-13.)

CARL ALTON ALLEN, E. M.,
Assistant Professor of Mining.

HARRY MUNSON SHOWMAN, E. M.,
Assistant Professor of Civil Engineering.

HYRUM SCHNEIDER, A. B., A. M.,
Instructor in Geology and Mineralogy.

GEORGE STEPHEN TILLEY, A. B., M. S.,
Instructor in Chemistry.

ILO IVAN TAYLOR, B. S. in C. E.,
Instructor in Mathematics.

CLARENCE EDWIN COOLIDGE, Ph. B.,
Instructor in Mechanical Engineering.

CLAUDE SYLVESTER JOHNSON, B. S. in M. E.,
Instructor in Mechanical Engineering.

FREDERICK S. TITSWORTH, C. E., E. M., L. L. B.,
Lecturer in Mining Law.

REGIS CHAUVENET, B. S., A. M., L.L. D.,
Special Lecturer in Mining and Metallurgy.

FELLOWS.

EDWARD JULIUS DITTUS, E. Met.,
Fellow in Metallurgy.

EDMUND MILLS FIELD, E. M.,
Fellow in Physics.

T. C. DOOLITTLE,
Registrar.

MABEL CLAIRE SHRUM, B. L. S.,
Librarian.

ALICE LYLE,
Secretary to the President.

ARTHUR L. RAE,
Engineer.

HENRY J. GUTH,
Pattern Maker

SPECIAL LECTURERS.

HON. EDWARD T. TAYLOR, Glenwood Springs, Colo.
The Panama Canal.

FRANK E. SHEPARD, Denver, Colo.
President, Denver Engineering Works Co.
The Development of Modern Mill Systems.

WALTER G. SWART, Denver, Colo.
American Zinc Ore Separating Co.
Filing Systems.
Recent Developments in Dry Milling.

THOMAS B. CROWE, Victor, Colo.
Superintendent, New Portland Mill.
The Metallurgy of Cripple Creek Ores.

GEORGE E. COLLINS, Denver, Colo.
The Economics of Metal Mine Accidents.

PROF. LUCIEN I. BLAKE, Boston, Mass.
Submarine Telegraph Co.
The New Theory of Energy.
Patents.

JOHN A. TRAYLOR, Denver, Colo.
President, Traylor Engineering Works Co.
Jigs.

L. S. PIERCE, Denver, Colo.
The Pierce Amalgamator.

W. H. TRASK, JR., Denver, Colo.
Central Colorado Power Co.
Hoisting.

GEORGE J. BANCROFT, Denver, Colo.
Ore Deposition.

JOHN L. MALM, Denver, Colo.
President, Western Metals Co.
The Future of Chemical Engineering.

JAMES M. McCLAVE, Denver, Colo.
The Garfield Tables.

HARRY J. WOLF, Denver, Colo.
The Heat of Formation.

MAX W. BALL, Washington, D. C.

The Organization and Work of the United States Geological Survey.

A. W. WARWICK, Denver, Colo.

Recent Cyanide Practice.

DR. M. J. SHIELDS, Washington, D. C.
American Red Cross Society.

First Aid to the Injured.

DR. PAUL MOORE STRAYER, Rochester, N. Y.

Social Service.

ALLISON J. STOCKER, Denver, Colo.
President, Denver Chamber of Commerce.

The Man and the Religious Forward Movement.

Men and Religion.

G. V. ALDRICH, New York, N. Y.

Investment of Life.

W. H. WORLEY, New York, N. Y.

Student Leadership.

CHARLES D. HURREY, New York, N. Y.
International Secretary, Y. M. C. A.

The Kind of Men Needed for Y. M. C. A. Work.

DR. W. B. NEWHALL, Denver, Colo.
Physical Director, Denver Y. M. C. A.

Sexual Hygiene.

The Physical Directorship of a City Y. M. C. A.

J. W. NIPPS, Denver, Colo.

Opportunity.

LOUIS HIEB, Denver, Colo.

Ceylon, Illustrated.

REV. B. B. TYLER, Denver, Colo.

Christianity and Statesmanship.

G. S. BILHEIMER, Denver, Colo.
General Secretary, Denver Y. M C. A.

The Association Secretaryship.

FATHER WILLIAM O'RYAN, Denver, Colo.

Manliness.

REV. GEORGE E. KEITHLEY, Golden, Colo.

A Series of Religious Discussions.

DR. FREDERICK T. BAYLEY, Denver, Colo.
Unconscious Responsibility.
A Man's Chance.

WILLIAM E. SWEET, Denver, Colo.
Things We Are Up Against.

JOHN M. CATES, Denver, Colo.
The Need of a Spiritual Environment in College.

REV. C. B. STEELE, Golden, Colo.
Helpfulness.

DR. JOHN INGLIS, Denver, Colo.
Do Missions Pay?
The Future of China.

REV. JOEL HARPER, Denver, Colo.
College Spirit.

REV. P. V. JENNESS, Denver, Colo.
The Heart of a Man.

D. D. WATSON, Denver, Colo.
A Man's Job.

REV. J. C. PAGE, Denver, Colo.
Paying Our Debts.

HISTORY, ORGANIZATION, FINANCIAL SUPPORT, AND LOCATION.

HISTORY.

The Colorado School of Mines was established by an act of the Territorial Legislature, approved February 9, 1874. Since that time the School has enjoyed a strong and steady growth in buildings, in equipment, in students, in Faculty, and in the strength and rigor of its courses. Additions were made to the original building of 1880, by the building of 1882, and by the building of 1890, now united and called the Hall of Chemistry. The Hall of Physics was erected in 1894, the Assay Laboratory in 1900, and Stratton Hall in 1904. The Heating, Lighting, and Power Plant was completed in 1906. The Administration Building, named Simon Guggenheim Hall for the donor, was also erected in 1906. The Gymnasium was completed in 1908. The Experimental Ore Dressing and Metallurgical Building was completed in 1912.

ORGANIZATION.

The corporate name of the institution is "The School of Mines." The general management of the School is vested by statute in a Board of Trustees, which consists of five members appointed by the Governor of the State, with the advice and consent of the Senate. The members of the Board of Trustees are appointed in alternating sets of two and three, and hold their office for a period of four years and until their successors are appointed and qualified. The Board of Trustees elect one of their number President. They also appoint a Secretary and a Treasurer either from their own number, or from some other suitable persons, as they may deem best. Any three of the Board of Trustees constitute a quorum for the transaction of business. The Constitution of Colorado recognizes the School of Mines as an Institution of the State.

FINANCIAL SUPPORT.

The Colorado School of Mines is supported by the income derived from the annual tax of one-fifth of a mill on each dollar of the assessed valuation of the property in the State. This is known as the "School of Mines Tax." In addition to this, the Legislature from time to time provides such special appropri-

ations as the means of the State treasury and the necessities of the School suggest.

LOCATION.

The Colorado School of Mines is in the south central part of the city of Golden, Jefferson County, Colorado. Golden is about thirteen miles from Denver, and can be reached by the Colorado & Southern Railroad from the Union Station, at the foot of Seventeenth street; by the Denver & Intermountain Railroad, from the Arapahoe street station, between Fourteenth and Fifteenth streets; or by the Denver & Northwestern Electric Railway, from the loop on Fifteenth street, between Arapahoe and Lawrence streets, Denver.

Golden has about three thousand inhabitants and is one of the oldest cities in Colorado. It is such a residence town as usually clusters around a college. The altitude is five thousand seven hundred feet above sea level, or about four hundred fifty feet higher than Denver. The climate is invigorating and pleasant, with open winters and a large proportion of clear days. The surrounding region is rich in the characteristic scenery of the Rocky Mountain region.

The Colorado School of Mines is peculiarly well situated to give students both a theoretical and a practical training. The equipment of the school enables the theoretical side to be well presented. The nearness to mines, mills, and smelteries offers unusual opportunities for inspection visits, and enables the student to see in actual operation every variety of mining and metallurgical work. In the Clear Creek canon are the numerous mills and concentrators of Gilpin and Clear Creek counties. At the Globe plant of the American Smelting and Refining Company, the treatment of lead ores and dry ores of gold and silver is illustrated. The many mining and metallurgical machinery plants of Denver afford an excellent opportunity for becoming acquainted with recent improvements in metallurgical design. At Colorado City are the Portland, the Standard, and the Golden Cycle mills; at Victor, the Independence, the Portland, and Ajax mills; and at Florence, the Union mill. The plant of the Colorado Fuel and Iron Company at Pueblo possesses all the recently invented and approved devices for the production of iron and steel and for the working of these products into marketable forms. At Pueblo are three lead smelteries, the Pueblo, the Eilers, and the Philadelphia, and the zinc smeltery of the Colorado Zinc Company. At Canon City are the plants of the Empire Zinc Company and of the United States Reduction and Refining Company; at Salida, the Ohio and Colorado smeltery, and at Leadville, the Arkansas Valley smeltery. The Black Hills, where good practice in gold milling and cyanidation is to be found, and the great copper smelteries of Montana, are easily reached.

At or near Golden are numerous clay mines, quarries, and extensive coal mines well equipped with hoisting and power machinery. In the Clear Creek canon, within a short ride from Golden, are the mining camps of Central City, Black Hawk, Idaho Springs, and Georgetown. Placer mining is carried on at Breckenridge. The well-known mining camps of Cripple Creek, Victor, Leadville, and Aspen, as well as the San Juan region including Silverton, Ouray, and Telluride, are also easily reached by train from Denver. Besides these the bituminous mines of the northern coal fields, the anthracite fields of Glenwood Springs, the coal fields of Trinidad, the oil fields of Florence, the iron mines of Wyoming, and the copper regions of Arizona and Montana, are easily reached.

No other mining school in the country has within easy access such a wide variety of mining properties, or such excellent opportunities for observing the latest and best milling and smelting operations.

BUILDINGS.

SIMON GUGGENHEIM HALL—Administration Building.

This building, the gift of Senator Simon Guggenheim, was erected and furnished at a cost of $80,000. The corner-stone was laid by the A. F. and A. M. of Colorado, October 3, 1905. It is one hundred sixty-four feet long by fifty-seven feet wide and is surmounted by an ornate tower. The first floor is devoted entirely to the department of geology and mineralogy, and includes lecture room, laboratory, office, two work rooms and a public museum; the second floor contains the library, the offices of the President, Secretary, and Registrar, the Faculty room and the Trustees' room; the third floor contains the Assembly Hall, two lecture rooms for mathematics, an office, and the Tau Beta Pi room. The building was dedicated October 17, 1906.

HALL OF CHEMISTRY.

This is a continuous group of brick buildings which comprise the buildings of 1880, 1882, and 1890. The combined buildings of 1880 and 1882 contain the main chemical laboratories. In the building of 1890 are the office and laboratory of the professor of chemistry, the chemical lecture room, the Museum of Applied Chemistry, three recitation rooms, the laboratories for gas and water analysis, and the freshman and sophomore drawing room.

ASSAY BUILDING.

This building, forty-six by ninety-two feet, was built in 1900 through funds contributed by the late W. S. Stratton, and enlarged in 1905 to allow for the installation of a new equipment of furnaces of the gasolene type. The design and equipment of this building are such as to make it the best of its kind in the country.

GYMNASIUM.

This building, costing $65,000, was completed in September, 1908. The first floor contains a room for boxing and wrestling, besides shower baths, locker room, and swimming pool finished in white marble and tiling. The second floor contains the offices and the Integral Club room. The third floor is the gymnasium room proper, fifty-five by one hundred feet, without posts. A gallery accommodates two hundred spectators.

HEATING, LIGHTING, AND POWER HOUSE.

The power plant, erected at a cost of $40,000, is designed to furnish light, heat, and power to the entire school. It is a simple but artistic brick building, eighty-three by one hundred twenty-two feet, with concrete floors and cement roof. The building is divided lengthwise into an engine room thirty-four feet wide, and a boiler room forty-five feet wide. A conduit six feet wide and seven feet high surrounds the engine room below the floor and is used for steam and electric mains. A brick-lined steel stack one hundred twenty-five feet high carries all smoke to the upper air and away from the buildings.

HALL OF PHYSICS.

This building, constructed of red pressed brick, consists of two floors and a basement, and was completed in the fall of 1894. The upper floor contains two physical laboratories, one for electricity and magnetism, and the other for heat and sound, an instrument room, and an office. The physics lecture and apparatus room, the photometry room, the physical laboratory for mechanics and light, the balance and apparatus room as well as a private office and laboratory occupy the first floor. The basement contains the electrometallurgical laboratory, pyrometry and high temperature laboratory, electro-plating room, a magnetic testing laboratory, a laboratory for the study of radioactivity and rare metals by spectroscopic methods, a storage battery room, and a switchboard with connections to all parts of the building.

STRATTON HALL.

The corner-stone of this building was laid by the A. F. and A. M. of Colorado, on November 20, 1902, and was completed in January, 1904. The basement wall and first story are of Lyons sandstone, in broken ashlar, topped by a story of gray Golden brick. The building is finished on the interior with red pressed brick. Little wood is used, except in the floors and staircases. The basement accommodates the metallurgical and electrical laboratories. The first floor contains two large lecture rooms, each with apparatus room and private office. The second floor, in one-half, accommodates the surveying and mechanics in one large lecture room, with apparatus room and private office, and in the other half a drafting room. The third floor is devoted entirely to a large drafting room for the junior and senior classes. The structure was named in honor of the late W. S. Stratton, whose gift of $25,000 made the building possible.

THE EXPERIMENTAL ORE DRESSING AND METALLURGICAL BUILDING.

This building, 100 by 150 feet, erected in 1912, was made possible by an appropriation of $75,000 by the Legislature of

Colorado. It is situated on the bank of Clear Creek, a short distance from the campus. It is intended to be not only a laboratory for the use of the students in ore dressing and metallurgy, but a testing plant for the benefit of the mining industry. It is the largest and most complete plant of its kind in the United States.

RESIDENCE OF THE PRESIDENT.

This is a brick building of two and one-half stories. It was built in 1888.

CARPENTER SHOP.

This is well equipped for the special demands which are continually arising in a technical school. The work varies from ordinary repair work to the careful construction of special apparatus needed in the various laboratories of the school.

MACHINE SHOP.

What has been said of the carpenter shop is equally true of the machine shop. It is imperative that the school have shops of its own, in order to keep its mechanical apparatus in proper working order, as well as to construct such apparatus as is necessary to carry on any new or original work.

LABORATORIES AND EQUIPMENT.

The Experimental Ore Dressing and Metallurgical Plant.

THE BUILDING.

The building of the experimental plant is situated on the bank of Clear Creek, a few blocks from the campus of the School. The slope of the bank is in itself sufficient to carry off water with considerable solid matter in suspension. The building is 98 by 141 feet 8 inches on the ground floor. The framework is of structural steel resting on concrete foundations which have been carried down to a substantial bed of gravel. The walls consist of two and one-half inches of cement mortar, reinforced by "hy-rib," and are of natural cement color. The roof is of elaterite resting on a two-inch sheathing of matched Oregon fir. The ground floor is concreted throughout and is divided into three sections of different elevations. Above the ground floor, but covering only a part of the area, are two suspended floors of reinforced concrete, supported by steel framework. The building is well lighted and is ventilated by an easily operated monitor ventilator.

POWER.

All machinery and apparatus requiring power is operated by alternating current motors supplied with current from the power house. For the generation of the current required, a producer-gas-power generator unit of 100 kv-a capacity has been installed in the power house. This unit is of Westinghouse design throughout and consists of a bituminous suction gas producer, a vertical three-cylinder gas engine, and a direct-connected alternating current generator.

The producer has a number of noteworthy features. The principal one, and the one which contributes so largely to its success, consists of the two distinct fire zones. This feature makes it possible to operate successfully on very low-grade fuel, and eliminates the difficulties usually arising from the tar and hydrocarbons given off and deposited during the process of gas making. Ordinary Colorado lignite coal is used. From this is produced a cool, clean gas with a heat value of from 115 to 130 B. t. u. a cubic foot. To eliminate the loss of power on account of a reduced intake pressure, a motor-driven, positive-pressure type of exhauster is used. This draws the gas from

the producer and delivers it to the engine at a pressure corresponding to about four inches of water.

The engine is of the standard Westinghouse vertical three-cylinder type, single acting, and using a four-stroke cycle. The cylinders are 15 by 14-inch (stroke). At a speed of 257 revolutions a minute, the engine, operating on the producer gas, delivers 118 b. h. p. Compressed air is used for starting, and both engine and producer can be started readily, even though they have stood idle for several days.

Direct-connected to the engine through a flanged coupling is a 100 kv-a, 2,300-volt, three-phase, 60-cycle generator. The current is transmitted at this voltage to the experimental plant where it is stepped down to the working voltage of 440. The installation is such that the 100 kv-a machine can be operated in parallel with a steam turbine in the power house. In case of an emergency all power can be supplied from the turbine alone.

WATER SUPPLY.

A concrete-lined well, 5 feet in diameter by 25 feet deep, has been sunk near the bank of Clear Creek. A 4 by 6-foot tunnel, 120 feet long, extends from the bottom of the well to a stratum of gravel under the bed of the creek. The well and tunnel have a storage capacity of 20,000 gallons. The pumping outfit consists of an automatic motor-driven, submerged-type centrifugal pump. This has a capacity of 100 gallons a minute against 50-pound pressure and pumps into pressure storage tanks of 2,500-gallon capacity. An ample supply of clear water is thus assured for all operations.

SECTIONS.

The plant, when fully equipped, will consist of four sections or units—sampling, concentration, cyanidation, and a fourth devoted to roasting and special apparatus, such as magnetic and electrostatic separators, dry tables, and flotation schemes. For general equipment the plant contains a Curtis air compressor, a two-stage centrifugal pump, three large water supply tanks operating under air pressure, two motor-operated platform elevators, giving control over all the floors, a Ruggles-Coles dryer, ore bins, track scales, turn tables, and ore cars.

The sampling section contains the following equipment: One Vezin sampler, one Brunton sampler, a portable feed hopper, one set of 12 by 20-inch Traylor rolls, one 2 by 6-inch Sturtevant roll jaw crusher, with accessories for finishing the sample such as laboratory crusher and pulverizers, bucking board, and riffles. In addition to this is a complete oil assay furnace outfit.

The concentrating unit contains one 7 by 10-inch Blake crusher, one Samson crusher, one 2D Gates gyratory crusher,

one set of 14 by 30-inch P. & M. M. rolls, one set of 12 by 24-inch P. & M. M. rolls, one set of triplex rolls, one 3½-foot Huntington mill and one 3½-foot Akron Chilean mill for regrinding, one Richards pulsator jig, one Harz jig of one compartment, one Harz jig of four compartments, one standard Card table, one No. 6 Wilfley table, one Wilfley slimer of latest design, one Johnston vanner, one Traylor vanner, one Richards pulsator classifier, one three-compartment classifier, two Callow cones, grizzlies, impact and revolving screens, sampling devices and the necessary sand pumps, elevators, and concentrate driers. In addition, the concentrator contains a battery of five 850-pound gravity stamps, equipped with amalgamating plates, Pierce amalgamator, and clean-up pan. A special feature of this unit is the installation of small-sized apparatus for the handling of small ore lots, i. e., a Callow preliminary ore-testing plant, a quarter-size Wilfley table and a quarter-size Card table. Through this arrangement, ore lots of any size whatever may be tested efficiently.

The cyanide section contains one 4-foot tube mill, one 3½ by 10-foot Pachuca tank, one Paterson agitator, a Dorr classifier, a Dorr thickener, thickening cones, a Moore filter, a Butters filter, one six-compartment zinc box, one lead-lined acid tank, one filter press for zinc slime, solution storage tanks and a small pebble mill. This department is also provided with small-scale apparatus in the shape of agitators and precipitating devices.

In the fourth section provision is made for the installation of special machinery, whereby its efficiency may be tested and comparison made with standard apparatus; for testing by roasting and magnetic or electrostatic separation, by dry tabling, and by such new processes and apparatus as may from time to time come before the metallurgical and mining public.

RESEARCH FEATURES.

Besides supplying the students of the School with a superb laboratory and thereby increasing the efficiency of their studies, the plant can be used as a research laboratory by the Faculty and the alumni of the School. Problems of ore treatment applicable to ores of wide occurrence—problems which affect not only a single mine but a whole district—will be investigated and the results published.

The facilities of the plant also will be available to experts who desire to make investigations of their own. In addition to all this, floor space has been reserved for testing new devices. An inventor who wishes to perfect his invention can have all the facilities of power, water, floor space, ore supply, and expert assistance at his command at a slight expense and will not be obliged to incur the heavy cost of equipping a plant for his one invention. The plant, then, will serve not only the

needs of the School in an educational way, but will be a means of acquiring much information of great value to the mining industry.

The plant is organized as a department of the School with Professor F. W. Traphagen as director, and Associate Professor William G. Haldane as manager in immediate and active charge of tests. Practical mill men and skilled mechanicians are employed as the need for them becomes apparent.

An advisory committee for the plant, consisting of the following men, has been appointed: D. W. Brunton, Denver, Colo., mining engineer; Philip Argall, Denver, Colo., manager, Stratton's Independence; John Tait Milliken, Colorado Springs, Colo., consulting engineer; Thomas B. Crowe, Victor, Colo., superintendent, New Portland mill; Walter G. Swart, Denver, Colo., western representative, American Zinc Ore Separating Company.

COLLECTION OF COMMERCIAL ORES.

Most collections of ores are classified according to their mineral contents, but the department of mining, following the example of the Bergakademie of Freiberg, Germany, is pursuing the policy of gathering average ore samples from every mining district. These are arranged geographically so that the typical ores of each mining district are placed together. Such an arrangement is found to be of great educational value to the classes in mining. The collection now numbers about 1,250 specimens.

MINERALOGICAL AND GEOLOGICAL LABORATORY AND CABINET.

Under the name cabinet is embraced not only the distinctively display collections, which may perhaps be called the cabinet proper, but also the other collections that have been prepared mainly for the purpose of class instruction. These collections are necessarily changing from year to year, as new material is constantly being added. This new material is obtained partly by purchase, but mainly by direct collecting, by gifts, and by means of exchange with other institutions. The display collections are not classified systematically, but are arranged in different cases with a view to displaying certain groups of minerals, or minerals from certain localities. The various collections, which together contain sixty-six thousand specimens, consist of display, type, and working or study collections of minerals, fossils, rocks, and ores. The rock collections include a general collection from different countries, one devoted to Colorado localities, and still others that cover particular countries or localities.

EXCHANGES.

The School has prepared a printed list of exchange material, covering both minerals and rocks. The list will be sent

to all who wish to arrange for exchanges. Correspondents should state what material they are prepared to offer in exchange. Letters should be addressed to Professor H. B. Patton, Golden, Colorado.

MINERALOGICAL LABORATORY.

Aside from the special advantages due to location, the department of geology is admirably equipped for practical teaching. The entire first floor of Guggenheim Hall is occupied by this department. The south end of the building is occupied by a commodious lecture room, with a seating capacity of more than a hundred, and by a separate mineralogical laboratory with table space for between fifty and sixty students, also by two small recitation rooms. On the extreme north end of the building is the public museum, devoted to a display of fine minerals. Additional space is provided for working rooms, offices, packing, and storage rooms.

METALLURGICAL COLLECTIONS.

The college has a fine collection of models from the works of Theodore Gersdorf, Freiberg, Saxony, which illustrate the best type of furnaces in this and other countries. Each model is made to scale and is complete in every detail. In addition to these models are the following to illustrate the best modern practice: Working model of a twenty-stamp mill, on a scale of one and one-half inches to the foot; working models of crushing rolls; working model of a Dodge crusher; model of modern blast furnace for lead-silver ores, with water jacket; smaller models, such as the complete set used in the famous Keyes and Arents lead-well suit. There is also a large collection of ores, ore dressing and metallurgical samples and products.

METALLURGICAL LABORATORY.

This laboratory is equipped with apparatus for the study of the quantitative relations of the various agencies taking part in metallurgical changes. The Junker, the Mahler Bomb, and the Parr calorimeters, the Wanner optical, the Le Chatelier, and Bristol electrical pyrometers, together with sets of the American Gas Furnace Company's gas furnaces, and Hoskin's gasolene furnaces are used for securing the desired temperature for experimentation. These furnaces also serve for the necessary assaying demanded in the metallurgical laboratory. Desks and apparatus are provided for small scale work in amalgamation, chlorination, and cyanidation; for larger scale work a battery of eight amalgamation pans, devised to be operated together or independently by power, several sets of cyanide tanks, including a Braun Laboratory Cyanide plant, and a chlorination barrel, are provided. There is also a Hendryx combined agi-

tator and filter, and a Hendryx agitator for hydro-metallurgical treatment of copper ores, dry chlorination apparatus, and a Paterson agitator for cyaniding slime. Provision for large scale work is made in the Experimental Ore Dressing and Metallurgical Plant.

ASSAY LABORATORY.

This laboratory is well equipped with parting, balance, and store rooms and office, and thirty-two coal-fired muffle furnaces. Each student has his own muffle, with his own coal bin, pulp balance, and desk, conveniently arranged with regard to his furnace; he has also access in the balance room to the best assay and pulp balances to be obtained on the market. The equipment of gasolene furnaces includes one crucible, four combination, and three muffle furnaces, one crude oil burner, one tempering furnace, and a bullion and tempering furnace, all of the F. W. Braun & Co. type; also three Case muffle furnaces, one improved Case high temperature muffle, and one Case crucible furnace, two Braun cupel machines, two Iler cupel machines and two bullion rolls, one of which is of the Braun type. In order to avoid dust, change of temperature, and direct sunlight, the balance room has no outside walls, and is lighted by means of skylights. The equipment here includes four special pulp balances, five silver, three gold balances, one Thompson multiple rider balance, and one Mine & Smelter Supply Company, Wilfrid Heusser No. 1,000 button balance, sensitive to 1-500 milligram. The variety of makes is as great as possible, so as to acquaint the student with the various mechanisms and adjustments in assay balances.

SURVEYING EQUIPMENT.

The equipment of the department of surveying is well adapted to the practical course given. For transit work there are twenty-five light mountain transits, of which six are provided with solar attachments for determining the meridian and latitude, and eleven with auxiliary telescopes for underground work. There are also three heavy transits, one of which is of English and one of German make. In addition to the transits there are two plane tables for taking topography. For leveling, seven wye levels and five dumpy levels of standard manufacture are used. The department is well supplied with leveling rods of various makes and types, stadia rods, hand levels, clinometers, flagpoles, and other accessories. The instruments are manufactured by such well-known firms as C. L. Berger & Sons, Buff & Buff, Heller & Brightly, Eugene Dietzgen & Co., Peter Heer & Co., W. and L. E. Gurley, Keuffel & Esser, William Ainsworth & Sons, Weiss & Heitzler, Young & Sons, Negretti & Zambra (English), and Max Hildebrand (German).

MUSEUM OF APPLIED CHEMISTRY.

The Museum of Applied Chemistry is on the first floor of the Hall of Chemistry. The object in establishing this museum is to aid, in a practical way, the courses in applied chemistry and metallurgy. Mounted specimens of raw materials, main products, by-products, and waste products of the various branches of technical chemistry and metallurgy are a direct stimulus in the study of these branches. The specimens already collected for the museum represent, among other things, the various stages of the manufacture of brick, fire brick, tile, cement, electrolytic alkalis, natural alkalis, electric furnace products, carborundum, alundum, carbide, rare metals, and ferro alloys.

CHEMICAL LABORATORIES.

The freshman, sophomore, and junior laboratories accommodate two hundred ninety-five students, and are equipped with especially designed tile-topped oak desks, provided with low reagent shelves, gas, water, filter pumps, and large porcelain sinks. The balance rooms are equipped with Sartorius, Becker, and Spoerhase balances. Gas is supplied to the building from a 300-light Detroit gas machine, which is connected with buried supply tanks outside the buildings. Good ventilation is obtained by means of two Sturtevant fans.

Gas Analysis Laboratory. Throughout the day the room affords an even temperature and is well lighted. Window space is reserved for a Lothar Meyer modification of the Bunsen eudiometer and a cathetometer. The laboratory also contains a complete Hemple and Elliott outfit, together with special apparatus for the collecting, storing, and handling of gases.

Water Analysis Laboratory. This laboratory adjoins and communicates with the gas analysis laboratory, and contains a full equipment of ordinary and special apparatus for water analysis. It is situated apart from the general laboratories and is particularly free from contaminating fumes.

Organic Laboratory The organic laboratory is fitted with exceptionally good hood equipment, especially designed to facilitate distillation, steam digestion, and other procedures common in organic synthetic work, and with a sunlight hood for chlorination. In connection with the large organic laboratory there is a smaller combustion room, fitted with the latest equipment for the ultimate analysis of organic substances, and for the determination of molecular weights.

HYDRAULIC LABORATORY.

The hydraulic laboratory contains weirs and orifice tanks for the determination of coefficients of discharge, calibrated tanks for water measurement, a steel pressure tank for artificial

heads, pumps for water supply, and gages for pressure. A hydraulic ram is used to illustrate this class of apparatus and for testing. A long sheet iron trough with a car over it is used for calibrating current meters. Water wheels and centrifugal pumps are tested for efficiency under various conditions of head and load. A swinging tank is used to measure jet reactions. Friction losses in pipes and elbows are measured. Hook gages are used for the accurate determination of low heads. Streams and ditches in the vicinity of Golden are gaged by means of the current meter, by rod floats, by slope, and by a Pitot tube.

PHYSICAL LABORATORIES.

The three physical laboratories are in the Hall of Physics. The laboratory for mechanics and light is on the first floor. Adjoining is a balance and instrument room and a dark room containing a complete Lummer-Brodhun photometer and an optical bench. On the second floor are the laboratories for electricity and magnetism, and for heat and sound. The equipment is particularly adapted to the instruction of students of engineering, and is designed to teach the principles of elasticity and efficiency of machines, composition and resolution of forces, various forms of motion, density, velocity and pitch of sound, focal length of lenses, magnifying power, and the principles of the construction of telescopes. The heat laboratory is particularly well equipped for calorimetry, heat expansion determinations, and for the determining of the mechanical equivalent of heat. A complete line of galvanometers, standard resistances, condensers, ammeters, voltmeters, dynamometers, permeameters, standard cells, and a Kelvin balance compose the electrical apparatus; in magnetism all the principles which underlie the construction of magnets for lifting purposes and for the separation of ores, are demonstrated in the laboratory.

ELECTROMETALLURGICAL LABORATORY.

The electrometallurgical laboratory is in the basement of the Hall of Physics. It consists of a main room, adjoining which are the storage battery room, a room for cleaning, polishing, and electroplating, and a room for pyrometry and high temperature work. The main laboratory covers a space 25 by 45 feet and contains sixteen desks. All desks are equipped with voltmeters, ammeters, rheostats, and terminals leading to a central switchboard where connections may be made to a full set of storage cells, direct or alternating current, and two large wire rheostats. Besides platinum electrodes, stirring devices, rotating anodes, and such chemical apparatus as is necessary for electro-chemistry, there is a complete equipment of electrical apparatus for studying the principles and conditions involved in electrolytic plants and in electric furnace work.

When a student has completed this course it is expected that he will be in a position to investigate and to understand all the conditions relating to an electrolytic plant, such as density of solutions, temperature effects, and the nature of different electrodes and electrolytes, also all the principles involved in the use and correction of pyrometers, the conversion of electrical energy into heat, and the efficiency of electrical furnaces. A few simple alloys are made and then such properties tested as their coefficients of elasticity, coefficients of heat expansion, resistance, temperature coefficients of resistance, and whatever magnetic properties they may possess. All the apparatus is so arranged that it may be used for research or investigation.

MECHANICS OF ENGINEERING LABORATORY.

The laboratory is provided with a motor-driven 100,000-pound Riehle testing machine arranged for experiments in tension, compression, shearing, and flexure of materials of construction. Extensometers for measuring elongations and compressions are employed. Numerous steel sections provide useful problems in determining centers of gravity and moments of inertia. Experiments to determine the strength of threaded bolts, riveted joints, welds, and nailed joints are included in the course. Tests of specific gravity and absorption of porous building materials such as brick and stone are also made.

The equipment for cement testing includes a 2,000-pound Riehle testing machine for testing briquettes in tension. A nest of sand sieves gages the sand used in tests. Standard Ottawa sand is used for briquettes as well as the local river sand in order to compare the latter with standard tests. Scales and volumeters are provided for measuring quantities in bulk. The specific gravity of cement is determined by means of Le Chatelier apparatus. A nest of fineness sieves and a set of very sensitive scales equip the student for the fineness test. Setting is determined by means of the complete Vicat apparatus. Trowels, spatulas, large slate mixing boards, beakers, moulds, damp box, and immersing vats, provide apparatus for the making and setting of briquettes and for the soundness tests. Moulds are used for making cubes of concrete for compression tests. The use of reinforced concrete is illustrated by complete models of forms for the manufacture of reinforced concrete columns and beams, and by numerous samples of various types of reinforcing bars.

ELECTRICAL LABORATORY.

This laboratory is equipped with standard voltmeters, ammeters and wattmeters, inductive and non-inductive resistances for artificial loads, a Thomson apparatus for induction experiments, a slip indicator for induction motors, an automatic speed

recorder which can he used for finding the acceleration curves of motors, an Alden absorption dynamometer for motor testing, a contact apparatus for alternating current and voltage wave form, a split phase rotary field apparatus, a 10,000 volt oil switch in a glass receptacle so that its action may be observed, a horn break cutout, tank and transformers used in insulator tests. The generators availahle for lahoratory work include a 100 kv-a 2,300 volt, 60 cycle, 3 phase Westinghouse alternator, driven by a Westinghouse producer gas engine, a 75 kw. 240 volt, 3 wire, d. c. Westinghouse generator, driven hy a 112 h. p. 2,300 volt, 3 phase, synchronous motor, a 75 kw. Bullock twin unit continuous current generator set, driven hy a 110 h. p. De Laval turhine, a 30 kw. 1,100 volt, 125 cycle, single phase General Electric alternator, a 15 kw. 130 volt compound, continuous current generator designed and built at the school, an 8 kw. Crocker-Wheeler generator, a 6 kw. 130 volt Westinghouse generator, a 2 kw. 120 volt compound Brush machine, a series arc light machine, and a small Edison shunt generator. The Bullock generators can be connected at the switchboard to supply the 120-240 volt 3 wire lighting and power circuits, or they can he put in parallel and thus supply more than 600 amperes for electrothermic work. The motors include a 10 h. p. 220 volt, 60 cycle, 3 phase constant speed induction motor of General Electric make, two 5 h. p. series motors with controllers, a 5 h. p. 3 phase, two-speed induction motor, used for electric drilling, a 4 h. p. single phase Wagner motor, a 400-2000 rev. per min. variable speed experimental motor designed and huilt at the school, a 20 h. p. series motor, and a large numher of 3 phase motors and shunt machines of standard makes in daily use about the shops and huildings. Two storage hatteries of 54 cells each are in daily use and are availahle for study. In addition to these generators and motors, a modern 5 panel d. c. switchhoard and 7 panel a. c. and d. c. switchhoard with the usual instruments, switches, and auxiliaries, afford excellent opportunities for the study of electric plant equipment. The work in electrical measurements and instrument testing is done in a special laboratory in the Hall of Physics. The engine room is utilized as a part of the dynamo lahoratory, hut the lahoratory in Stratton Hall, equipped with numerous circuit outlets and portahle instruments, is used chiefly for the study of motors and their auxiliaries.

MINING LABORATORY.

The laboratory work in mining is carried on principally at the tunnel belonging to the School. The equipment here consists of numerous drills which are taken apart, reassembled, and used by the student; forges, anvils and tools for blacksmithing; the air receiver, valves, gages, fuses and switches connected

with the compressed air and electric power transmission from the power plant; two mining cars; materials for track laying; and all other supplies usually found at a tunnel house. Among the makes of rock drills used by the students are Rand, Ingersoll, Sergeant, Leyner, McKiernan, Wood, Hardsocg, Shaw, Waugh, and Temple-Ingersoll. All of the mountings, such as bars, tripods, and arms, and a supply of drill steel, are also provided. In the laboratory at the school are two working size models of the Bleichert system of aerial trams; numerous models of mines; an explosive tester; a collection of rock cores taken by diamond drills; models of timbering methods; many maps of actual mines; instruments for measuring ventilation; thousands of lantern slides illustrating mining operations; samples of wire ropes and drill steels; lamps of the open and safety patterns; a dry placering machine; and many photographs of mines and operations.

RARE METALS LABORATORY.

This laboratory is equipped for research in the rare metals along two principal lines, radioactivity and spectroscopy. Under radioactivity are such elements as radium, uranium, thorium, actinium, and polonium. To investigate these there is all the apparatus necessary for accurate quantitative observations with the electrometer, and also with a field type of electroscope which gives very good quantitative results, but is especially designed to investigate the radioactivity of mineral waters, gases, and ores found in the field which carry radioactive elements. For the investigation of other rare elements there is a small thirty-six inch, three prism spectrograph and a large fourteen-foot Littrow spectrograph. The equipment contains all necessary accessories such as arcs, spark terminals, various types of vacuum tubes, vacuum pump, and a photographic outfit. In conducting research the work necessarily branches into chemical and electrochemical lines. Therefore the laboratory is also provided with separate desks which contain a complete chemical and electrochemical equipment for each student.

MECHANICAL ENGINEERING LABORATORY.

The heating, lighting, and power plant is well equipped for mechanical engineering laboratory practice. The boiler room contains the following principal equipment: One 200 h. p. and one 100 h. p. Babcock & Wilcox water tube boilers, each equipped with a chain grate; one 80 h. p. tubular boiler equipped with plain grate; Green Engineering Company fuel economizers; Babcock & Wilcox independently fired super-heater; Webster feed-water heater, boiler feed and vacuum pumps and injectors; a 125 by 5-foot self-supporting steel stack supplemented by a steam driven 42-inch Sirocco fan for induced draft;

eight 25-ton steel bunkers for coal storage; and a 125 h. p. Westinghouse double-flow gas producer equipped with wet and dry scrubbers, mixing and gas storage tank, and motor-driven exhauster.

The engine room contains the following principal apparatus: 10 by 12-inch high speed Russell engine; 6 by 9-inch throttling Sturtevant engine; 75 kw. De Laval steam turbine geared to twin generators; 7 by 6-inch two-cylinder vertical Westinghouse Jr. engine; 15 by 14-inch three-cylinder vertical Westinghouse gas engine direct connected to alternator; 6¾ by 14-inch single Fairbanks, Morse & Company gas engine; 8¾ by 14-inch Priestman oil engine; a J. George Leyner Engineering Works two-stage air compressor—capacity 275 cubic feet air a minute; and a small Westinghouse air-brake.

DRAWING ROOMS.

Freshman and Sophomore. This occupies the upper floor of the Hall of Chemistry. The floor area is about four thousand square feet. It is lighted by windows on the north, east, and west, and by eight large skylights in the roof. A suitable office for the instructors is in a central position, in which all drawings are filed and all records are kept. Each student is provided with a drawing table, a drawer, a drawing board, and a stool. The present equipment accommodates about one hundred fifty students. There are many models to aid the students in their work.

Junior and Senior. The entire third floor of Stratton Hall is used for the junior and senior drawing. The room is 90 by 60 feet, lighted by windows and a large skylight. Each student is provided with a drawing table, a drawer, a drawing board, and a stool. Most of the drawing tables are independent and adjustable. The room has recently been equipped with especially constructed tables for the advanced work of the seniors. The present equipment accommodates about one hundred sixty students. There is a blue print room fully equipped with an adjustable printing frame and all other necessary appliances. In one corner of the room is the office of the instructors, where all drawings and records are filed. There are for the use of the students a complete set of trade catalogues and a great many blue prints from outside concerns. These are kept up to date. One-half of the second floor of Stratton Hall is used as a drawing room for the senior class.

REQUIREMENTS FOR ENTRANCE.

FRESHMAN CLASS.

Unit Course. A unit course of study is defined as a course covering a school year of not less than thirty-six weeks, with five periods of at least forty-five minutes each a week.

Fifteen Units are required for entrance, of which twelve are specified, and three may be chosen from a list of electives.

Specified Units.

Essentials of Algebra	1	unit
Advanced Algebra	½	unit
Plane Geometry	1	unit
Solid Geometry	½	unit
Languages, other than English	2	units
English	3	units
History	2	units
Physics	1	unit
Chemistry	1	unit
Specified Units	12	
Elective Units	3	
Total Units for Entrance	15	

Elective Units.

The three elective units may be selected from the following list: Drawing, Shop Work, Mathematics, Greek, French, German, Spanish, History, English, Science, Psychology, Political Economy. In allowing credit for drawing and shop work two forty-five minute periods will be regarded as equivalent to one forty-five minute period of classroom work. Half units are accepted in all studies, except in physics and chemistry, provided that not less than one full unit shall be accepted in language.

Methods of Entrance.

(a) By Certificate.

A graduate of an Accredited High School in the state of Colorado will be admitted without examination upon the presentation of proper credentials from the principal of his high school, provided that the studies he has successfully completed cover the requirements for entrance. Blanks for this purpose will be sent, on application to the President.

Graduates of Accredited High Schools in other states will be accepted in the same manner as graduates of Accredited High Schools in Colorado.

(b) By Examination.

All other candidates for admission will be required to pass entrance examinations. These examinations are held in Golden.

For the benefit of any student who cannot, on account of the distance, conveniently take the examination in Golden, arrangements will be made so that he may take the examination under the direction of some responsible person at or near his own home.

Entrance examinations for the class of 1917 will be held in Golden on Wednesday, Thursday, and Friday, August 27, 28, and 29, 1913.

Entrance examinations for the class of 1918 will be held in Golden on Wednesday, Thursday, and Friday, September 2, 3, and 4, 1914.

It is the opinion of the Faculty of the Colorado School of Mines that every candidate for the freshman class should have taken a thorough course of at least four years in a good High School or in a Manual Training High School, and during the last year of his preparation should have had a thorough review of mathematics, or should have received an education equivalent to one of these. The work of the school is so exacting that students who are not well prepared cannot expect to succeed after entrance. Special attention should be given to the preparation in physics, chemistry, and mathematics.

DESCRIPTION OF THE UNITS REQUIRED FOR ENTRANCE.

ENGLISH (3 Units).

(a) **Grammar.** The student should have a sufficient knowledge of English grammar to enable him to point out the syntactical structure of any sentence which he meets in the prescribed reading. He should also be able to state intelligently the leading grammatical principles when he is called upon to do so.

(b) **Reading.** The books prescribed by the Joint Committee on Uniform Entrance Requirements in English form the basis for this part of the work.

(c) **Composition.** Regular and persistent training in both written and oral composition should be given throughout the entire school course. The topics should be so chosen as to give practice in the four leading types of prose discourse, namely, description, narration, exposition, and argument.

(d) **Rhetoric.** The instruction in this subject should include the following particulars: Choice of words, structure of sentences and paragraphs, the principles of narration, description, exposition, and argument. The teacher should distinguish

between those parts of rhetorical theory which are retained in text books merely through the influence of tradition and those which have a direct bearing upon the composition work. The former may be safely omitted.

HISTORY (2 Units).

Any two of the following periods may be offered:

I. Ancient History, with special reference to Greek and Roman History, with a short introductory study of the more ancient nations and the chief events of the early middle ages, down to the death of Charlemagne.

II. Mediaeval and Modern European History, from the death of Charlemagne to the present time.

III. English History.

IV. American History, or American History and Civil Government.

PHYSICS (1 Unit).

The equivalent of Carhart and Chute's **High School Physics**, or Gage's **Principles of Physics**, together with systematic laboratory practice such as is outlined in Crew and Tatnall's **Laboratory Manual in Physics.**

CHEMISTRY (1 Unit).

The equivalent of Bradbury's **Elementary Chemistry** or Remsen's **Briefer Course of Inorganic Chemistry, with Experiments.**

MATHEMATICS (3 Units).

I. **Essentials of Algebra.** (1 Unit). The four fundamental operations for rational algebraic expressions; factoring; complex fractions; the solution of equations of the first degree containing one or more unknown quantities; radicals; theory of indices; quadratic equations and equations containing one or more unknown quantities that can be solved by the methods of quadratic equations; problems dependent on such equations.

II. **Advanced Algebra.** (½ Unit). This course should begin with a thorough review of the essentials. Later work should cover an introduction to the graphical representation of linear and simple quadratic expressions; ratio and proportion; variation; binomial theorem; the progressions; an elementary treatment of series; partial fractions; complex numbers and logarithms.

III. **Plane Geometry.** (1 Unit.) Completed, with the solution of original exercises and numerical problems.

IV. **Solid Geometry.** (½ Unit). Properties of straight lines and planes; of dihedral and polyhedral angles; of projection; of polyhedrons, including prisms; of pyramids and the regular solids; of cylinders, cones and spheres; of spherical triangles, and the measurement of surfaces and solids.

The two units required in languages other than English may be offered in Greek, Latin, French, German, or Spanish.

ADMISSION TO ADVANCED STANDING.

Applicants who are graduates of technical or scientific schools or colleges of good standing will be admitted without examination upon the presentation of proper credentials and will be permitted to take any subject taught in connection with the regular courses, provided, in the opinion of the instructor, their previous experience and training will enable them to pursue the subject with profit. Each case will be judged on its own merits, but applicants will be advised to become candidates for a degree and to complete one of the regular courses of the school. Graduates will find the advanced work well adapted to fit them for professional engineering work.

Applicants who have partially completed the course in technical or scientific schools or colleges of good standing will be admitted without examination upon the presentation of proper credentials. Due credit will be allowed for the successful completion of work which is equivalent to that given in the Colorado School of Mines. Plates of drawings, laboratory note books, and catalogues of the institution attended, should be submitted with applications for advanced standing. **The college does not admit special students.** Each applicant for advanced standing is expected to enroll in one of the regular courses and to become a candidate for a degree. All credits given to advanced standing students are given provisionally, with the understanding that such credits may be withdrawn at any time in case a student fails to maintain a creditable standing. Application blanks will be furnished, on request to the President.

DEGREES.

The degree of E. M. (Engineer of Mines) will be conferred upon a candidate who

(a) Completes the prescribed work of the freshman and sophomore years.

(b) Completes the prescribed work in one of the four groups: Metal Mining, Coal Mining, Mining Geology, or Metallurgy.

(c) Completes enough additional work to make a total of 100 credit hours for the junior and senior years.

(d) Takes the senior trip and presents an acceptable thesis.

The degree of Ch. E. (Chemical Engineer) will be conferred upon a candidate who

(a) Completes the prescribed work of the freshman and sophomore years.

(b) Completes the prescribed work in the Applied Chemistry group.

(c) Completes enough additional work to make a total of 100 credit hours for the junior and senior years.

(d) Presents an acceptable thesis.

Each senior must submit to the Faculty, not later than November 1, the subject of his thesis, which must be approved by the professor concerned. Each thesis must be typewritten or printed on eight and one-half by eleven-inch paper, bound in book form, and submitted not later than March 1.

No diploma will be delivered until the thesis is handed in, the full requirements of the course of study are satisfied, and all accounts with the college are settled.

The degree of M. S. (Master of Science) will be conferred upon a candidate, who already holds a degree from this School or its equivalent, according to the standard of the Colorado School of Mines, who completes work equivalent to fifty credit hours, chosen with the approval of the Faculty, from either the postgraduate or undergraduate courses, and who presents an acceptable thesis.

DEPARTMENTS OF INSTRUCTION.

TABULAR VIEW.

Freshman Year.

Required of All Students.

FIRST SEMESTER.	Lect. Hr.	Lab. Hr.	SECOND SEMESTER.	Lect. Hr.	Lab. Hr.
Mathematics I. (p. 110).. College Algebra	5		Mathematics III (p. 111) Analytic Geometry	5	
Mathematics II. (p. 111). Trigonometry	3		Mathematics IV (p. 112) Calculus	3	
Chemistry I. (p. 98)..... General Chemistry	5		Chemistry II. (p. 98).... General Chemistry	5	
Chemistry III. (p. 99)... Qualitative Analysis Lectures	2		Chemistry IV. (p. 99)... Qualitative Analysis Lectures	2	
Chemistry V. (p. 99).... Qualitative Analysis Laboratory		6	Chemistry VI (p. 100)... Qualitative Analysis Laboratory		12
Mechanical Engineering I. (p. 87)..... Elementary Machine Design Lectures	2		Mechanical Engineering III. (p. 87)..... Descriptive Geometry Lectures	2	
Mechanical Engineering II. (p. 87)..... Engineering Drawing		9	Mechanical Engineering IV. (p. 88)..... Descriptive Geometry Drawing		6
Geology I. (p. 75)..... General Geology	3		Geology II. (p. 76)..... General Geology	3	

TABULAR VIEW.

Sophomore Year.

Required of All Students.

FIRST SEMESTER.	Lect. Hr.	Lab Hr.	SECOND SEMESTER.	Lect. Hr.	Lab. Hr.
Mathematics V. (p. 112). Calculus	5		Mathematics VI. (p. 112) Calculus	5	
Physics I. (p. 108)..... General Physics Lectures	5		Physics III. (p. 109)..... General Physics Lectures	5	
Physics II. (p. 108)..... Physical Laboratory		4	Physics IV. (p. 109)..... Physical Laboratory		4
Chemistry VII. (p. 100).'. Industrial Chemistry	2		Chemistry VIII (p. 100). Industrial Chemistry	2	
Chemistry IX. (p. 100).. Quantitative Analysis Lectures	1		Chemistry X. (p. 101).. Quantitative Analysis Lectures	1	
Chemistry XI. (p. 101).. Quantitative Analysis Laboratory		6	Chemistry XII (p. 101).. Quantitative Analysis Laboratory		6
Mechanical Engineering V. (p. 88)..... Machine Design Lectures	2		Mechanical Engineering VII. (p. 88)..... Machine Design Lectures	2	
Mechanical Engineering VI. (p. 88)..... Machine Design Drawing		3	Mechanical Engineering VIII. (p. 89)..... Machine Design Drawing		3
Geology III. (p. 76)..... Crystallography	2	6	Geology IV. (p. 76)..... Mineralogy	2	6

Civil Engineering 1. (p. 83.) (Plane Surveying) is given in the summer after the close of the sophomore year.

TABULAR VIEW.

Metal Mining—Group I.

Junior Year.

FIRST SEMESTER.	Lect. Hr.	Lab. Hr.
Mining V. (p. 56)..... **Principles of Metal Mining** Credit 2	2	
Mining VII. (p. 56)..... **Methods of Metal Mining** Credit 3	3	
Electrical Engineering I. (p. 95)..... **Direct Current Machinery, Lectures** Credit 3	3	
Electrical Engineering II. (p. 95)..... **Direct Current Machinery, Laboratory** Credit 1		3
Metallurgy III. (p. 65)... **Fuels, Refractories, Iron and Steel** Credit 3	3	
Mechanical Engineering IX. (p. 89)..... **Steam Engines and Boilers, Lectures** Credit 1	1	
Mechanical Engineering X. (p. 89)..... **Steam Engines and Boilers, Drawing** Credit 2		6
Civil Engineering II (p. 83)..... **Mechanics of Engineering** Credit 5	5	
Civil Engineering IV (p. 84)..... **Laboratory, Section a** Credit 1		3
English I. (p. 114)..... Credit 1	1	

SECOND SEMESTER.	Lect. Hr.	Lab. Hr.
Mining I. (p. 54)..... **Mineral Land Surveying** Credit 1	1	
Mining II. (p. 54)..... **Mine Surveying** Credit 1	1	
Mining III. (p. 55)..... **Mine Surveying Field Work** This course is given in the summer following the close of the junior year. Credit 2½		
Mining VIII (p. 57)..... **Methods of Metal Mining** Credit 3	3	
Electrical Engineering III. (p. 95)..... **Alternating Current Machinery, Lectures** Credit 3	3	
Electrical Engineering IV. (p. 96)..... **Alternating Current Machinery, Laboratory** Credit 1		3
Metallurgy I. (p. 64)..... **Assaying, Lectures** Credit 1	1	
Metallurgy II. (p. 64).... **Assaying, Laboratory** Credit 2		6
Metallurgy IV. (p. 66)... **Lead, Antimony** Credit 2	2	
Mechanical Engineering XI. (p. 90)..... **Steam Engines and Boilers, Lectures** Credit 2	2	
Mechanical Engineering XII. (p. 90)..... **Steam Engines and Boilers, Drawing** Credit 1		3
Civil Engineering III. (p. 84)..... **Mechanics of Engineering** Credit 5	5	
Civil Engineering IV. (p. 84)..... **Laboratory, Section b** Credit 1		3
Geology VI. (p. 78)..... **Lithology** Credit 3	2	3
English II. (p. 114)..... Credit 1	1	

TABULAR VIEW.

Metal Mining—Group I.

Senior Year.

Degree E. M. (Engineer of Mines).

FIRST SEMESTER.	Lect. Hr.	Lab. Hr.	SECOND SEMESTER.	Lect. Hr.	Lab. Hr.
Mining IV. (p. 55)..... **Mine Mapping** Credit 1		3	Mining X (p. 58)..... **Practices of Metal Mining** Credit 2	2	
Mining IX. (p. 57)..... **Practices of Metal Mining** Credit 2	2		Mining XVI. (p. 61)..... **Economics of Metal Mining** Credit 2	2	
Mining XV. (p. 60)..... **Mine Examinations and Reports** Credit 1	1		Metallurgy XI (p. 68)... **Gold, Silver, Copper** Credit 5	5	
Mining XVII. (p. 61).... **Mining Laboratory** This course is given in groups throughout the year Credit ½			Metallurgy XIX. (p 72). **Metallurgical Practice** This course is given in groups throughout the semester. Credit 1.		
Metallurgy VII (p. 67)... **Ore Dressing** Credit 5	5		Civil Engineering V (p. 85)..... **Hydraulics** Credit 2	2	
Metallurgy XVIII. (p. 72) **Metallurgical Practice** Credit 1		3	Civil Engineering VI. (p. 85)..... **Hydraulic Laboratory** Credit 1		3
Mechanical Engineering XIII. (p. 90)..... **Compressed Air** Credit 2	2		Geology XI (p. 79)..... **Economic Geology** Credit 3	3	
Mechanical Engineering XIV. (p. 91)..... **Power Plant Design Lectures** Credit 2	2		English IV (p. 114)..... Credit 1	1	
Mechanical Engineering XV. (p. 91)..... **Power Plant Design Drawing** Credit 2		6	Thesis..... Credit 2.		6
Geology X. (p. 79)..... **Ore Deposits** Credit 3	3				
English III. (p. 114)..... Credit 1	1				
Thesis..... Credit 1		3			

The specified credit hours for the junior and senior years amount to 91. The remaining credits, 9, to make a total of 100 credit hours for the two years, may be selected from the elective courses, or from courses offered in other groups.

TABULAR VIEW.

Coal Mining—Group II.

Junior Year.

FIRST SEMESTER.	Lect. Hr.	Lab. Hr.
Mining V. (p. 56)..... **Principles of Metal Mining** Credit 2	2	
Mining VII. (p. 56)..... **Methods of Metal Mining** Credit 3.	3	
Electrical Engineering I. (p 95)..... **Direct Current Machinery, Lectures** Credit 3	3	
Electrical Engineering II. (p. 95)..... **Direct Current Machinery, Laboratory** Credit 1		3
Metallurgy I. (p. 64).... **Assaying Lectures** Credit 1	1	
Metallurgy II. (p. 64).... **Assaying Laboratory** Credit 2		6
Metallurgy III. (p. 65)... **Fuels, Refractories, Iron and Steel** Credit 3	3	
Mechanical Engineering IX. (p. 89)..... **Steam Engines and Boilers, Lectures** Credit 1	1	
Mechanical Engineering X. (p. 89) ..... **Steam Engines and Boilers, Drawing** Credit 2		6
Civil Engineering II (p. 83)..... **Mechanics of Engineering.** Credit 5.	5	
English I. (p. 114)..... Credit 1	1	

SECOND SEMESTER.	Lect. Hr	Lab Hr
Mining I. (p. 54)..... **Mineral Land Surveying** Credit 1	1	
Mining II. (p. 54)..... **Mine Surveying** Credit 1	1	
Mining III. (p. 155)..... **Mine Surveying, Field Work** This course is given in the summer following the close of the junior year. Credit 2½		
Mining VIII. (p. 57)..... **Methods of Metal Mining** Credit 3	3	
Mining XI. (p. 58)..... **Principles of Coal Mining** Credit 2	2	
Mining XII. (p. 59)..... **Principles of Coal Mining** Credit 2	2	
Metallurgy IV (p. 66).... **Lead, Antimony.** Credit 2.	2	
Electrical Engineering III. (p. 95)..... **Alternating Current Machinery, Lectures** Credit 3	3	
Electrical Engineering IV. (p. 96)..... **Alternating Current Machinery, Laboratory** Credit I		3
Mechanical Engineering XI (p. 90)..... **Steam Engines and Boilers, Lectures** Credit 2.	2	
Mechanical Engineering XII. (p. 90)..... **Steam Engines and Boilers, Drawing** Credit 1.		3
Civil Engineering III. (p. 84)..... **Mechanics of Engigineering** Credit 5	5	
Civil Engineering IV. (p. 84)..... **Laboratory** Credit 1		3
English II. (p. 114)..... Credit 1	1	

TABULAR VIEW.

Coal Mining—Group II.
Senior Year.
Degree E. M. (Engineer of Mines).

FIRST SEMESTER.	Lect Hr.	Lab. Hr.
Mining IV. (p. 55)..... **Mine Mapping** Credit 1		3
Mining IX. (p. 57)..... **Practices of Metal Mining** Credit 2	2	
Mining XIII. (p. 59)..... **Practices of Coal Mining** Credit 2	2	
Mining XV. (p. 60)..... **Mine Examinations and Reports** Credit 1	1	
Mining XVII. (p. 61).... **Mining Laboratory** This course is given in groups throughout the year. Credit ½		
Metallurgy VII (p. 67).. **Ore Dressing** Credit 5	5	
Mechanical Engineering XIII. (p. 90)..... **Compressed Air** Credit 2	2	
Mechanical Engineering XIV. (p. 91)..... **Power Plant Design Lectures** Credit 2	2	
Mechanical Engineering XV. (p. 91)..... **Power Plant Design Drawing** Credit 2		6
English III. (p. 114).... Credit 1	1	
Thesis..... Credit 1		3

SECOND SEMESTER.	Lect. Hr.	Lab Hr.
Mining X. (p. 58)..... **Practices of Metal Mining** Credit 2	2	
Mining XIV. (p. 60)..... **Practices of Coal Mining** Credit 2	2	
Mining XVI. (p. 61) .... **Economics of Metal Mining** Credit 2	2	
Mining XVIII. (p. 61)... **Economics of Coal Mining** Credit 1	1	
Mining XXII. (p. 63).... **Rescue and First Aid Work** Credit I	1	
Chemistry XX. (p. 103).. **Coal and Gas Anaylsis** Credit 1		3
English IV. (p. 114)..... Credit 1	1	
Thesis..... Credit 2		6

The specified credit hours for the junior and senior years amount to 83. The remaining credit hours, 17, to make a total of 100 hours for the two years, may be selected from the elective courses, or from courses offered in other groups.

TABULAR VIEW.

Metallurgy—Group III.

Junior Year.

FIRST SEMESTER.	Lect. Hr.	Lab. Hr.
Mining V. (p. 56)..... **Principles of Metal Mining** Credit 2	2	
Metallurgy I. (p. 64).... **Assaying Lectures** Credit 1	1	
Metallurgy II. (p. 64)... **Assaying Laboratory** Credit 3		9
Metallurgy V. (p. 66).... **Fuel, Refractories, Iron and Steel** Credit 5	5	
Electrical Engineering I. (p. 95)..... **Direct Current Machinery, Lectures** Credit 3	3	
Electrical Engineering II. (p. 95)..... **Direct Current Machinery, Laboratory** Credit 1		3
Chemistry XIII. (p. 101). **Quantitative Analysis Lectures** Credit 1	1	
Chemistry XIV (p. 102). **Quantitative Analysis Laboratory** Credit 2		6
Mechanical Engineering IX. (p. 89)..... **Steam Engines and Boilers, Lectures** Credit 1	1	
Mechanical Engineering X. (p. 89)..... **Steam Engines and Boilers, Drawing** Credit 1		3
Civil Engineering II. (p. 83)..... **Mechanics of Engineering** Credit 5	5	
English I. (p. 114)..... Credit 1	1	

SECOND SEMESTER.	Lect. Hr.	Lab. Hr.
Mining I. (p. 54)..... **Mineral Land Surveying** Credit 1	1	
Mining II. (p. 54)..... **Mine Surveying** Credit 1	1	
Mining III.(p. 55)..... **Mine Surveying Field Work** This course is given in the summer following the close of the junior year Credit 2½		
Mining VIII. (p. 57)..... **Methods of Metal Mining** Credit 3	3	
Metallurgy IV. (p. 66)... **Lead, Antimony** Credit 2	2	
Metallurgy VI. (p. 67)... **Bismuth, Zinc, Cadmium** Credit 2	2	
Electrical Engineering III. (p. 95)..... **Alternating Current Machinery. Lectures** Credit 3	3	
Electrical Engineering IV. (p. 96)..... **Alternating Current Machinery. Laboratory** Credit 1.		3
Chemistry XVII. (p. 102) **Metallurgical Chemistry, Lectures** Credit 1	1	
Chemistry XVIII. (p. 102) **Metallurgical Chemistry, Laboratory** Credit 2		6
Mechanical Engineering XI (p. 90)..... **Steam Engines and Boilers, Lectures** Credit 1	1	
Mechanical Engineering XII. (p. 90)..... **Steam Engines and Boilers, Drawing** Credit 1		3
Civil Engineering III (p. 84)..... **Mechanics of Engineering** Credit 5	5	
English II. (p. 114)..... Credit 1	1	

TABULAR VIEW.

Metallurgy—Group III.

Senior Year.

Degree E. M. (Engineer of Mines.)

FIRST SEMESTER.	Lect. Hr.	Lab. Hr.	SECOND SEMESTER.	Lect. Hr.	Lab. Hr.
Mining IV. (p. 55)..... **Mine Mapping** Credit 1		3	Metallurgy XI. (p. 68)... **Gold, Silver, Copper** Credit 5	5	
Mining VII. (p. 56)..... **Methods of Metal Mining** Credit 3	3		Metallurgy XII. (p. 69).. **Laboratory** Credit 1		3
Metallurgy VII. (p. 67).. **Ore Dressing Lectures** Credit 5	5		Metallurgy XIV (p. 70).. **Metallography Laboratory** Credit 1		3
Metallurgy IX (p. 68).... **Nickel, Mercury and Other Metals** Credit 3	3		Metallurgy XVII (p. 71). **Electrometallurgy Lectures** Credit 3	3	
Metallurgy X. (p. 68).... **Laboratory** Credit 1		3	Metallurgy XIX (p. 72). **Metallurgical Practice** This course is given in groups throughout the semester Credit 1		
Metallurgy XIII (p. 69).. **Metallography Lectures** Credit 1	1		English IV. (p. 114)..... Credit 1	1	
Metallurgy XV. (p. 70).. **Electrometallurgy Lectures** Credit 2	2		Thesis..... Credit 2		6
Metallurgy XVI. (p. 71). **Electrometallurgy Laboratory** Credit 1		3			
Metallurgy XVIII (p. 72) **Metallurgical Practice** Credit 1		3			
English III. (p. 114)..... Credit 1	1				
Thesis..... Credit 1		3			

The specified credit hours for the junior and senior years amount to 86½. The remaining credit hours, 13½, to make a total of 100 credit hours for the two years, may be selected from the elective courses, or from courses offered in other groups.

TABULAR VIEW.

Mining Geology Group IV.

Junior Year.

FIRST SEMESTER.	Lect. Hr.	Lab. Hr.
Mining V. (p. 56)..... **Principles of Metal Mining** Credit 2	2	
Electrical Engineering I. (p. 95)..... **Direct Current Machinery, Lectures** Credit 3	3	
Electrical Engineering II. (p. 95)..... **Direct Current Machinery, Laboratory** Credit 1		3
Metallurgy I. (p. 64)..... **Assaying Lectures** Credit 1	1	
Metallurgy II. (p. 64).... **Assaying Laboratory** Credit 2		6
Metallurgy III. (p. 65)... **Fuel, Refractories, Iron and Steel** Credit 3	3	
Geology V. (p 77)..... **Advanced Geology** Credit 5	5	
Mechanical Engineering IX. (p. 89)..... **Steam Engines and Boilers, Lectures** Credit 1	1	
Mechanical Engineering X. (p. 89)..... **Steam Engines and Boilers, Drawing** Credit 1		3
Civil Engineering II. (p. 83)..... **Mechanics of Engigineering** Credit 5	5	
English I. (p. 114)..... Credit 1	1	

SECOND SEMESTER.	Lect. Hr.	Lab. Hr.
Mining I. (p. 54)..... **Mineral Land Surveying** Credit 1	1	
Mining II. (p. 54)..... **Mine Surveying** Credit 1	1	
Mining III. (p. 55)..... **Mine Surveying Field Work** This course is given in the summer following the close of the junior year Credit 2½		
Mining VIII. (p. 57)..... **Methods of Metal Mining** Credit 3	3	
Electrical Engineering III. (p. 95)..... **Alternating Current Machinery. Lectures** Credit 3	3	
Electrical Engineering IV. (p. 96)..... **Alternating Current Machinery. Laboratory** Credit 1		3
Metallurgy IV. (p. 66)... **Lead, Antimony** Credit 2	2	
Geology VI. (p. 78)..... **Lithology** Credit 3	2	3
Geology VII (p. 78)..... **Geological Field Work** This course is given in the summer between the junior and senior years Credit 3		
Geology XVI (p. 81)..... **Geologic and Topographic Maps** Credit 2		6
Mechanical Engineering XI. (p. 90)..... **Steam Engines and Boilers, Lectures** Credit 1	1	
Mechanical Engineering XII. (p. 90)..... **Steam Engines and Boilers, Drawing** Credit 1		3
Civil Engineering III. (p. 84)..... **Mechanics of Engineering** Credit 5	5	
English II. (p. 114)..... Credit 1	1	

TABULAR VIEW.

Mining Geology—Group IV.
Senior Year.
E. M. (Engineer of Mines.)

FIRST SEMESTER.	Lect. Hr.	Lab. Hr.	SECOND SEMESTER.	Lect. Hr.	Lab Hr.
Mining IV. (p. 55)..... **Mine Mapping** Credit 1		3	Mining XVI. (p. 60)..... **Economics of Metal Mining** Credit 2	2	
Mining VII. (p. 56)..... **Methods of Metal Mining** Credit 3	3		Metallurgy XI (p. 68)... **Gold, Silver, Copper** Credit 5	5	
Mining XV. (p. 60)..... **Mine Examinations and Reports** Credit 1	1		Geology XI. (p. 79)..... **Economic Geology** Credit 3	3	
Metallurgy VII. (p. 67).. **Ore Dressing** Credit 5	5		Geology XII. (p. 80)..... **Mining Geology** Credit 3	3	
Geology IX. (p. 79)..... **Microscopic Petrography** Credit 3		6	English IV (p. 114)..... Credit 1	1	
			Thesis..... Credit 2		6
Geology X. (p. 79)..... **Ore Deposits** Credit 3	3				
English III. (p. 114)..... Credit 1	1				
Thesis..... Credit 1		3			

The specified credit hours for the junior and senior years amount to 88½. The remaininig credit hours, 11½, to make a total of 100 credit hours for the two years, may be selected from the elective courses, or from the courses offered in other groups.

TABULAR VIEW.

Applied Chemistry—Group V.

Junior Year.

FIRST SEMESTER.	Lect. Hr.	Lab. Hr.
Chemistry XIII. (p. 101) **Quantitative Analysis Lectures** Credit 1	1	
Chemistry XIV. (p. 102). **Quantitative Analysis Laboratory** Credit 2		6
Chemistry XXVII (p. 104)..... **Stoichiometry** Credit 1	1	
Chemistry XXIX (p. 105) **Organic Chemistry Lectures** Credit 3	3	
Chemistry XXX (p. 105) **Organic Chemistry Laboratory** Credit 2		6
Metallurgy III. (p. 65)... **Fuels, Refractories, Iron and Steel** Credit 3	3	
Mechanical Engineering IX. (p. 89)..... **Steam Engines and Boilers, Lectures** Credit 1	1	
Mechanical Engineering X. (p. 89)..... **Steam Engines and Boilers, Drawing** Credit 1		3
Civil Engineering II. (p. 83)..... **Mechanics of Engineering** Credit 5	5	
Electrical Engineering I. (p. 95)..... **Direct Current Machinery, Lectures** Credit 3	3	
Electrical Engineering II. (p. 95)..... **Direct Current Machinery, Laboratory** Credit 1		3
English 1 (p. 114)..... Credit 1	1	

SECOND SEMESTER.	Lect. Hr.	Lab. Hr.
Chemistry XXVIII (p. 104)..... **Stoichiometry** Credit 1	1	
Chemistry XXXI (p. 105) **Organic Chemistry Lectures** Credit 2	2	
Chemistry XXXII (p. 105)..... **Organic Chemistry Laboratory** Credit 2		6
Chemistry XXXIII (p. 106)..... **Industrial Inorganic Chemistry. Lectures and Laboratory.** Credit 2	1	3
Mechanical Engineering XI. (p. 90)..... **Steam Engines and Boilers, Lectures** Credit 1	1	
Mechanical Engineering XII. (p. 90)..... **Steam Engines and Boilers, Drawing** Credit 1		3
Civil Engineering III. (p. 84)..... **Mechanics of Engigineering** Credit 5	5	
Electrical Engineering III. (p. 95)..... **Alternating Current Machinery. Lectures** Credit 3	3	
Electrical Engineering IV. (p. 96)..... **Alternating Current Machinery Laboratory** Credit 1		3
English II. (p. 114)..... Credit 1	1	

TABULAR VIEW.

Applied Chemistry—Group V.
Senior Year.
Degree Ch. E. (Chemical Engineer).

FIRST SEMESTER.	Lect Hr.	Lab. Hr.	SECOND SEMESTER.	Lect. Hr.	Lab. Hr.
Chemistry XXV (p. 103). **Physical Chemistry Lectures and Laboratory** Credit 2	1	3	Chemistry XXIV. (p. 103) **Rare Metals, Laboratory** Credit 1		3
Chemistry XXXIV. (p. 106)..... **Industrial Organic Chemistry, Laboratory** Credit 2		6	Chemistry XXVI. (p. 104) **Electrochemical Analysis, Lectures and Laboratory** Credit 2	1	3
Chemistry XXXV (p. 106)..... **Theoretical Chemistry** Credit 1	1		Chemistry XXXVI. (p. 106)..... **Theoretical Chemistry** Credit 1	1	
Chemistry XXXVII (p. 107)..... **Technology of the Non-Metals** Credit 2	2				
Metallurgy I. (p. 64..... **Assaying, Lectures** Credit 1	1		Metallurgy XIV. (p. 70). **Metallography Laboratory** Credit 1		3
Metallurgy II. (p. 64).... **Assaying, Laboratory** Credit 2		6			
Metallurgy X (p. 68).... **Laboratory** Credit 1		3	Geology XIV. (p. 81).... **Ceramic Geology Lectures and Laboratory** Credit 3	2	3
Metallurgy XIII. (p. 69). **Metallography, Lectures** Credit 1	1				
Metallurgy XV. (p. 70).. **Electrometallurgy Lectures** Credit 2	2		English IV. (p. 114)..... Credit 1	1	
Metallurgy XVI. (p. 71.. **Electrometallurgy Laboratory** Credit 1		3	Thesis..... Credit 2		6
Geology XV. (p. 81)..... **Geology of the Non-Metals** Credit 3	3				
English III. (p. 114)..... Credit 1	1				
Thesis..... Credit 1		3			

The specified credit hours for the junior and senior years amount to 74. The remaining credit hours, 26, to make a total of 100 for the two years, may be selected from elective courses, or from courses offered in other groups.

MINING

Professor George William Schneider.
Assistant Professor Carl Alton Allen.

I. MINERAL LAND SURVEYING. Lectures.

Credit one hour.

This course is intended to instruct the student in the methods of procedure and in the practice employed in the acquisition of title to mineral lands, both in the United States and in foreign countries, but special attention is given to the practice in the western states of the United States. The course includes the method of subdividing the public lands; the filing of locations, making preliminary surveys, preparing and filing certificates more particularly for lode claims, placer claims, mill sites and tunnel sites, together with the necessary legal requirements; the methods of filing on and acquiring coal, lumber, and stone lands; the methods of filing on and the acquisition of water rights; the preparation of papers, plans and specifications for dams, ditch lines, pipe lines, and reservoir sites; the duties of a United States Mineral Surveyor. The actual problems given in the examination of applicants for commissions as mineral surveyors, together with the field methods, office work, and report forms employed are assigned to the student so that he may be prepared for the examination.

Prerequisites: The completed work of the freshman year.
Mathematics V and VI.
Civil Engineering I.

One hour a week during the second semester of the junior year.

Required in Groups I, II, III, and IV.

(Schneider, Allen.)

II. MINE SURVEYING. Lectures.

Credit one hour.

Among the subjects covered by this course are the following: The instruments for mine surveying, their use and care; surface surveys and traverses; the determinations of the meridian by star and solar methods; carrying the meridian underground; the survey of underground workings; underground connections;

determination of dip, strike, and thickness of mineral deposits from drill-hole data; records of surveys; mine models.

Prerequisites: The completed work of the freshman year.
Mathematics VI.
Civil Engineering I.

One hour a week during the second semester of the junior year.

Required in Groups I, II, III, and IV.

(Schneider, Allen.)

III. MINE SURVEYING. Field Work.

Credit two and one-half hours.

This course is intended to co-ordinate with Courses I and II. The work is so planned as to embrace practice in the laying out, on the ground, of mineral claims, i. e., rectangular and angular lode claims, placer claims, mill and tunnel sites. These surveys are made on the mountains adjacent to Golden. The practice in underground work is given at one of the neighboring mining districts where a typical mine is selected which provides the problems common to mine surveying, such as shaft plumbing, adit and drift traversing, and connections through stopes, winzes, raises, and other workings. The student thus gets an opportunity to set up instruments, to take measurements, and to secure other necessary data in confined places where artificial light is employed, and where many obstacles are met. In this work the students are organized into surveying squads so that, by rotation in duties, each man acquires skill in the various lines of work.

Prerequisites: Courses I and II.

Four weeks in the summer after the close of the junior year.

Required in Groups I, II, III, and IV.

(Schneider, Allen.)

IV. MINE MAPPING. Drawing.

Credit one hour.

This course covers the making of mine maps. The first portion applies to the subject matter covered in Course I and the first part of Course III, and comprises the platting of mineral claims. The examples given are actual cases taken from the records of the United States Surveyor General and consequently give to the student an intimate acquaintance with the actual practice of mineral surveyors. Accuracy in protracting, in drawing, and in scaling, and the necessity of neatness and simplicity are emphasized. The latter portion of the course covers the making of mine maps and employs such data as have been obtained in Course III. Plans, sections, and projections are prepared so that the principal features of mine

workings may be shown. Assay plans, maps for litigation, and mine models are also studied.

Prerequisites: The completed work of the freshman and sophomore years.

Course III.

Three hours a week during the first semester of the senior year.

Required in Groups I, II, III, and IV.

(Schneider.)

V. PRINCIPLES OF METAL MINING. Lectures.

Credit two hours.

This course is introductory and fundamental to all the succeeding metal mining courses. It has no technical features. The main topics discussed are the history and importance of the mining industry; its influence on the settlement and civilization of the world; the definitions of the elementary terms employed in mining; the practical methods of field prospecting with the necessary equipment, food supplies, and medicines for different localities and countries; the principal surface indications of mineral veins and deposits; the principal mining districts and mines of the world; the general types of ore bodies; ores and gangues; characteristic methods of extraction and reduction; and a general statistical resume.

Prerequisites: The completed work of the freshman year. The completion of, or enrolment in, Geology III.

Two hours a week during the first semester of the junior year.

Required in Groups I, II, III, and IV.

(Schneider, Allen.)

VII. METHODS OF METAL MINING. Lectures.

Credit three hours.

This course includes the consideration of the various methods of excavation, from hand shovels to the large mechanical excavators; the development and working of surface ore bodies; open pit and milling systems and quarrying; the methods of opening underground mines; the sizes and shapes of tunnels and shafts; an exhaustive treatment of the different methods of shaft sinking and tunnel driving; the prospecting of underground passages; the usual methods of timbering and lining shafts, adits, levels, and stopes; the kinds and properties of timber for mine use; the seasoning and preservation of timber; special methods of framing; the uses of steel and concrete.

Prerequisites: The completed work of the freshman year.

Three hours a week during the first semester.

Required in the junior year in Group I and II and the senior year in Groups III and IV.

(Allen.)

VIII. METHODS OF METAL MINING. Lectures.

Credit three hours.

The first part of this course deals exclusively with placer mining and covers the details of sluices and their operation; the methods of excavating the gravel for the sluice; the theory and practice of hydraulicking; the uses of the different kinds of dredges; dry placering; drift mining; and the thawing of frozen gravel. The course is supplemented by a trip of inspection to the famous Breckenridge, Colorado, placer district.

The course takes up next the ways of blocking out underground ore bodies; the correct intervals between levels; the different methods of stoping with the range of application to different kinds of ore bodies and to flat or steeply pitching veins; the advantages and disadvantages of underhand stopes, overhand rill-cut, long back, and shrinkage stopes; a careful consideration of complete systems of development and mining such as transverse shrinkage stopes and pillars, square set stopes, top slicing, sub-level drifts and back caving, and the various methods of filling and flushing. Not only are the general methods of mining in the principal camps of the world described, but representative mines are selected and their methods discussed in detail with explanations of the governing conditions, advantages, and disadvantages. Cost comparisons also enter into the discussion.

Prerequisites: The completed work of the freshman year.

Three hours a week during the second semester of the junior year.

Required in Groups I, II, III, and IV.

(Allen.)

IX. PRACTICES OF METAL MINING. Lectures.

Credit two hours.

In this course the student takes up the detailed study of the practical operations involved in metal mining. The principal topics discussed are drills and drilling, which include hand and machine drilling with a detailed study of the different types of piston and hammer drills operating with different forms of power; drill steel; sharpening and tempering; boring for water or oil; core drilling, commonly known as diamond or shot drilling; the placing of drill holes for breaking ground; blasting, with a study of the different kinds of high and low explosives; the handling of explosives and their effect in breaking ground; ore extraction; handling material in working places; underground roads; mine cars; gravity roads and planes; tram-

ming and animal haulage; mechanical haulage; hoisting of materials; hoisting methods including unbalanced, balanced, Koepe, Whiting, and Butte regeneration systems; hoisting problems; hoisting engines; hoisting ropes; cages; skips; buckets; automatic devices; safety devices; and signals.

Prerequisites: The completed work of the freshman and sophomore years.

Two hours a week during the first semester of the senior year.

Required in Groups I and II.

(Schneider.)

X. PRACTICES OF METAL MINING. Lectures.

Credit two hours.

This is a continuation of Course IX and treats of the following topics: Surface transportation including human, animal, and mechanical methods; trails, roads; railroads; loads; wagons; motor trucks; cars; steam, air, and gas locomotives and motors; electric motors; wire ropeways; cableways; conveyors; mechanical devices for loading and unloading; drainage of water in mines; theory of infiltration of water; drainage problems; natural drainage including surface and underground diversions; dams and water tight linings; siphons; mechanical drainage; hoisting of water; underground drainage systems; mine waters; drainage districts; ventilation of mines; theory of ventilation; gases and their detection; natural ventilation, and devices used to produce ventilation; mechanical ventilation and appliances used to produce ventilation; fans; blowers; systems of ventilation; problems in ventilation; lighting of mines; electric, gas, oil, and candle light; open flame lamps; safety lamps; sanitary conditions; dangers and accidents; mine fires; inspection of mines; state laws relating to the operation of mines; health and care of workmen; surface arrangement of mines including types of head frames, tipples, ore bins, terminal stations, shops and mine buildings; selection of mine equipment. The course concludes with lectures descriptive of the mines which are visited on the senior trip.

Prerequisite: Course IX.

Two hours a week during the second semester of the senior year.

Required in Groups I and II.

(Schneider.)

XI. PRINCIPLES OF COAL MINING. Lectures.

Credit two hours.

The subjects given in this course include the history and growing importance of the coal industry; the geographical distribution of coal with special reference to the fields of the

United States; the general geological features of coal areas; the origin of coal; the kinds of coal and their general use; structural features of coal beds such as cleavage, faulting, and rolling; prospecting coal bearing areas and drilling, stripping, and mining of surface seams; the means of developing deep seams. Shafts and slopes as a means of entry are compared.

Prerequisites: The completed work of the freshman year.

Two hours a week during the second semester of the junior year.

Required in Group II.

(Allen.)

XII. METHODS OF COAL MINING. Lectures.

Credit two hours.

In this course are taught the systems of developing and excavating coal deposits; the dips of beds, the kinds of roof and floor formations, cleavage, drainage, haulage, and ventilation in connection with the planning of coal mine workings; single and multiple entry systems; advancing and retreating as applied to longwall, room-and-pillar, and panel systems of mining; the ways of turning, widening, and driving rooms and crosscuts; the methods of breaking coal at the face and the drawing of pillars in thin, thick, flat, rolling, and steep beds of anthracite and bituminous coals; the mining of very thick or contiguous seams; calculations for the position and size of various kinds of pillars; the working of ground and surface subsidence; culm flushing; and the planning of shaft and slope bottoms.

Prerequisites: The completed work of the freshman year.

Two hours a week during the second semester of the junior year.

Required in Group II.

(Allen.)

XIII. PRACTICES OF COAL MINING. Lectures.

Credit two hours.

The special features of hoisting and drainage particularly applicable to coal mining are here studied. Under the head of coal mine ventilation are given the kinds, properties, origin, effects, and detection of coal mine gases; natural means of ventilation, and the use of simple devices; the fresh air requirements of men and animals as influenced by the amounts of obnoxious gases, natural earth temperatures, and barometric pressures; the laws of circulating air currents; the splitting and control of air by sollars, bridges, casts, doors, brattices, and stoppings; the construction and usefulness of safety lamps; systematic inspection of coal mines; reasons for the reversal of ventilation; the care and stabling of mine ani-

mals; spontaneous fires; gas and dust explosions; accidents from falling roofs.

Prerequisites: The completed work of the freshman and sophomore years.

Two hours a week during the first semester of the senior year.

Required in Group II.

(Allen.)

XIV. COAL MINING EQUIPMENT. Lectures.

Credit two hours.

Among the subjects covered by this course are the construction, cost, use, and operation of the various types of coal-cutting machines, such as punchers, post punchers, shearing machines, and bar, disc and chain cutters operated by compressed air or electricity; the types and construction of pit cars; mechanical devices for loading coal into pit cars; the design, installation, and housing of mine fans; head-frames and tipple-houses; car tipples; automatic cages; bar, revolving, and shaking screens; automatic weighing devices; railroad track scales; compressed air and electric box-car loaders; provisions for supplying wagon trade. The course concludes with lectures upon the coal mines which are visited on the senior trip.

Prerequisites: The completed work of the freshman and sophomore years.

Course XIII.

Two hours a week during the second semester of the senior year.

Required in Group II.

(Allen.)

XV. MINE EXAMINATION AND REPORTS. Lectures.

Credit one hour.

This course covers the valuation of mines, of surface and underground equipment, and of development work; the sampling of ore bodies; the calculation of the amount of gross value of ore reserves; the valuation of ore bodies; sampling of placer deposits; sampling of coal seams; valuation of coal seams; sampling and valuation of other mineral bodies; percentage of ore recoverable; probable cost of converting reserves into a source of revenue; economic factors in mine valuation; mine reports; and the practices of prominent mining engineers throughout the world.

Prerequisites: The completed work of the freshman and sophomore years.

Courses I, II, and III.

Text: Rickard, **The Sampling and Estimation of Ore in a Mine.**

One hour a week during the first semester of the senior year.

Required in Groups I, II, and IV.

(Schneider.)

XVI. ECONOMICS OF METAL MINING. Lectures.

Credit two hours.

This course is a continuation of Course XV and is intended to acquaint the student with mine incorporation and capitalization. The following topics are discussed: Mine economics; mine investments; mine frauds; mine promotions; mining companies; mining costs; maintenance; depreciation; and amortization.

Prerequisite: Course XV.

Two hours a week during the second semester of the senior year.

Required in Groups I, II, and IV.

(Schneider.)

XVII. MINE LABORATORY.

Credit one-half hour.

The work in this course is done about three-quarters of a mile from the campus at a point on the slope of Mt. Zion, where the School has built and equipped a mine shop and has started a 7 by 8-foot adit. The shop contains a complete equipment of mining tools for blacksmithing, timbering, track-laying, piping, and repair work of all kinds. It also contains all of the rock drills, mine cars, and other apparatus used in the underground work. The students work in squads of three or four and perform all of the usual duties attending the driving of an adit, such as track-laying, timbering, drilling with air and electric machines, blasting, mucking, and tramming. Under the instruction of a practical miner, the students learn to sharpen and temper their own steel for the varying conditions of ground and for the several makes of drills. Opportunity is afforded students to do extra work investigating the efficiency and power consumption of various makes of drills, and the relative properties of various brands of high explosives.

Prerequisites: The completed work of the freshman and sophomore years.
Completion of, or enrolment in, Course IX.

A minimum of seven half-days during the senior year.

Required in Groups I and II.

(Schneider.)

XVIII. ECONOMICS OF COAL MINING. Lectures.

Credit one hour.

The topics covered by this course are those which have a di-

rect bearing upon the success or failure of coal mining ventures. Advantage is taken of the fact that this course is given contemporaneously with Course XVI, which includes features common to all kinds of mining. Hence this course does not deal with generalities in mining economics but discusses only such subjects as the methods of acquiring coal lands from individuals and governments; the inefficiency of past mining methods; the relative efficiency of hand and machine work; the power used in coal mining; the market and trade conditions; legal inspection of coal mines; investigations concerning gas and dust explosions; other coal mine accidents; wage versus contract systems; the treatment of employes; the issuance of supplies; company charges for insurance and physicians; check weighmen; the approximate cost of each operation in mining; fixed charges; average prices of coal at the mines; influence of railroad rates on coal markets; the duties of mine officials and engineers; company liabilities; the disposal of unsalable products; the necessity of washing coal; provisions for supplying the local trade about mines.

Prerequisites: The completed work of the freshman and sophomore years.

Courses XI and XII.

One hour a week during the second semester of the senior year.

Required in Group II.

(Allen.)

XIX. MINE ACCOUNTING. Lectures. (Elective.)

Credit one hour.

This course is intended to acquaint the student with the fundamentals of bookkeeping, single and double entry; mine accounts; standardization of mine accounts; and classification of mine accounts. The course is not intended to make bookkeepers, but to give the mining engineer such a knowledge of the principles of accounting as to enable him to analyze statements and to direct a bookkeeper in the keeping of accounts so that he may secure such statements as he desires.

Prerequisites: The completed work of the freshman year.

One hour a week during the first semester of the junior year.

(Schneider.)

XX. MINE ACCOUNTING. Lectures. (Elective.)

Credit two hours.

This course is a continuation of Course XIX. As a competent analysis of accounts is at the very foundation of competent and economical management, the following topics are

discussed: Cost account and cost analysis; books employed; forms; card and loose leaf systems; balance sheets; and reports.

Prerequisite: Course XIX.

Two hours a week during the second semester of the junior year.

(Schneider.)

XXI. MINE MANAGEMENT. Lectures. (Elective.)

Credit two hours.

This course is intended to give the student a general idea of mine management and involves, in addition to the subjects relating to mine management in other courses, the general principles of mine management which include efficiency engineering, co-ordination of human and mechanical units, economy of purchase and consumption of supplies; organization of the mine force; mine labor; administration of the mine force; contracts; law of contracts; specifications; leasing systems; marketing of ores and bullion; ore contracts.

Prerequisites: The completed work of the freshman and sophomore years.

This course is open only to seniors.

Two hours a week during the second semester of the senior year.

(Schneider.)

XXII. FIRST AID AND RESCUE WORK. Lectures.

Credit one hour.

This course has for its object the instruction of students in the rescue and care of injured persons before the services of a physician can be secured. They are taught how to apply temporary dressings for wounds, and splints for broken bones; how to stop bleeding or to dress burns. The rescue work deals largely with the use of self-contained breathing apparatus for use in irrespirable atmospheres such as are met in mine fires or in gas explosions. The advantages and disadvantages of the various types of apparatus now on the market are explained and the students are given practice wearing the helmets in sulphur fumes. This course is carried on in such a manner that credit for the work can be given by the United States Bureau of Mines and certificates granted to the students.

Prerequisites: The completed work of the freshman and sophomore years.

This course is open only to seniors.

One hour a week during the second semester of the senior year.

Required in Group II.

(Allen.)

METALLURGY.

Professor Frank Weiss Traphagen.
Special Lecturer, Regis Chauvenet.
Associate Professor William George Haldane.
Fellow Edward Julius Dittus.

I. ASSAYING. Lectures.

Credit one hour.

The theory of assaying is developed in this course. Special attention is given to questions of slag constitution and formation, the relations of minerals, the constitution of ore and the necessary fluxes, the relation of weights, and the development of the assay ton system with calculations to familiarize the student with the various systems in vogue. The aim of the course is to make the student thoroughly familiar with the principles involved so that his work becomes a scientific procedure rather than a "rule-of-thumb" process.

Prerequisites: The completed work of the freshman and sophomore years.

References: Fulton, **Manual of Fire Assaying.**
Lodge, **Assaying.**

One hour a week during one semester.

Required in Groups I, II, III, IV, and V.

(Traphagen.)

II. ASSAYING. Laboratory.

Credit, two hours in Groups I, II, IV, and V; three hours in Group III.

Special attention is directed toward making this course as practical as possible. Although the importance of accurate work is at no time lost sight of, constant efforts are made to enable the student to handle a large amount of work in as short a time as possible. As nearly as may be, the student is put under conditions that exist in a smeltery, and is made familiar with the systems prevailing in the best conducted laboratories, so that in the end he may be able to take his place at once in such a laboratory without undergoing a "breaking-in" course after leaving school. The work includes the usual assays called for in the laboratory of mine, mill, or smeltery, and the methods,

besides those in use so satisfactorily for many years, include also such "short cuts" as have been introduced by assayers who have several hundred assays to make daily. The course covers the fusibility of slags of definite composition made up by careful calculation; the fluxing of limestone ores and silicious ores for practice; the running of lead mixtures of known lead, silica, and base content to determine the influence of foreign elements and variable gangue; the assays of sulphide and oxide ores of lead; the assay of gold and silver ores of different types by various methods, with a comparison of results; the assay of zinciferous and cupriferous gold and silver ores; the assay of arsenical and antimonial ores; and the crucible and scorification assay of mattes and concentrates.

In Group III additional work is given on various metallurgical products, on gold, silver, copper, and lead bullions, the various solutions, by-products, and products of the cyanide process, on platinum, tin, mercury, and miscellaneous ores and products.

Prerequisites: The completed work of the freshman and sophomore years.

References: **Colorado School of Mines, Notes on Assaying.**
Fulton, **Manual of Fire Assaying.**
Lodge, **Assaying.**

Required in all groups: six hours a week in Groups I, II, IV and V; nine hours a week in Group III, during one semester.

(Traphagen, Dittus.)

III. METALLURGY. Lectures.

Credit three hours.

The subjects included in this course comprise an extension of the work on fuels, involving the calculation of air required for combustion, weight of the products of combustion, heat carried away by flue gases, the heat value of various solid, liquid, and gaseous fuels; pyrometry and the modern methods of high temperature measurements; calorimetry and the various means of determining the calorific power of fuels; the fundamental metallurgical principles; and a study of the different types of metallurgical furnaces and their applications.

Iron and Steel. On account of the marked development in the metallurgy of iron, the general application of labor-saving devices, and the basal metallurgical principles involved in its production, this subject is considered first. Pig iron manufacture, with a study of the blast furnace and its accessories; the chemistry of the blast furnace; the utilization of furnace gases; the calculation of charges; the puddling process for wrought iron; the manufacture of steel by the Bessemer, open hearth, cementation, and crucible processes, with a consider-

ation of the reactions involved; and the various furnaces and applications incident to a modern plant are taken up in logical order.

Prerequisites: The completed work of the freshman year.
Physics I to IV, inclusive.
Chemistry X and XII.

References: Richards, **Metallurgical Calculations.**
Greenwood, **Iron and Steel.**
Stoughton, **Iron and Steel.**

Three hours a week during the first semester of the junior year.

Required in Groups I, II, IV, and V.

(Haldane, Dittus.)

IV. METALLURGY. Lectures.

Credit two hours.

Lead. The metallurgy of lead is considered in the following order: Properties of lead and its compounds; ores of lead; sampling and purchasing of lead ores; fluxes and fuel; reverberatory smelting; smelting in the ore hearth; roasting of ores, including the chemistry of the roasting process; blast furnace smelting, including construction, chemistry of the blast furnace, calculation of furnace charges, and treatment of products; softening, desilverization, and refining of base bullion; Pattinson process; Park's process; German and English cupellation.

Antimony. This metal is so closely allied to lead that its metallurgy very properly follows the metallurgy of lead. The extraction of this metal from its ores and the refining of the product by present methods are discussed at length; considerable attention is given to the common antimonial alloys and furnace products in which this metal is found.

Prerequisite: Course III.

Reference: Hoffman, **Metallurgy of Lead.**

Two hours a week during the second semester of the junior year.

Required in Groups I, II, III, and IV.

(Haldane, Chauvenet.)

V. METALLURGY. Lectures.

Credit five hours.

This covers the subjects of Course III but involves additional work in the study of the heat balance, blast furnace design, and a closer consideration of the details in the various methods of steel manufacture.

Prerequisites: The completed work of the freshman year.
Chemistry X and XII.
Physics I to IV, inclusive.

Five hours a week during the first semester of the junior year.

Required in Group III.

(Haldane, Chauvenet, Dittus.)

VI. METALLURGY. Lectures.

Credit two hours.

Bismuth. The several processes for the extraction of bismuth from its ores and metallurgical products are dealt with in detail, together with the approved methods of refining the product.

Zinc. The following topics are considered: Calcination; roasting and distillation by various methods, with a detailed study of furnace types—direct fired, semi-gas, and gas fired; manufacture of retorts; the refining of spelter and the general cost of production.

Cadmium. The lectures on this topic deal with the sources of ores, wet and dry extraction, and electrolytic methods.

Prerequisite: Course V.

References: Ingalls, **Metallurgy of Zinc and Cadmium.**
Schnabel, **Handbook of Metallurgy.**

Two hours a week during the second semester of the junior year.

Required in Group III.

(Haldane, Chauvenet, Dittus.)

VII. ORE DRESSING. Lectures.

Credit five hours.

The following represent the main divisions under which this subject is studied: Jaw and gyratory breakers; rolls; gravity, steam, and pneumatic stamps; special crushing and fine grinding apparatus; apparatus for sizing, including the various types of screens and classifiers; concentrating machines, including jigs, tables and vanners; dry, magnetic, electrostatic, and surface tension concentration; coal washing; and the layout of plants.

Prerequisites: The completed work of the freshman and sophomore years.

Five hours a week during the first semester of the senior year.

Required in Groups I, II, III, and IV.

(Traphagen.)

IX. METALLURGY. Lectures.

Credit three hours.

Nickel, Mercury, and Other Metals. This work includes a series of lectures on the properties and metallurgy of mercury, tin, nickel, cobalt, and other metals not treated elsewhere, with a general discussion of the principles of treatment and of the best current practice.

Seminar. Weekly meetings are held for the consideration of current journal articles on metallurgy, the discussion of thesis work, and practice in the abstracting of papers.

Administration. A series of lectures covers the various practices followed in the division of the work of plants and the handling of men, together with a study of the systems of keeping accounts and of reporting results.

Prerequisites: The completed work of the freshman and sophomore years.

Courses I, II, and IV.

Reference: Schnabel, **Handbook of Metallurgy.**

Three hours a week during the first semester of the senior year.

Required in Group III.

(Traphagen.)

X. METALLURGY. Laboratory.

Credit one hour.

This course is intended to supplement the lecture work of the junior year and includes work with optical and electrical pyrometers; heat value of solid, liquid, and gaseous fuels by the Junker, Parr, and Bomb calorimeters; heat treatment of steel; the thermit process; and the desilverization of base bullion.

Prerequisites: The completed work of the freshman and sophomore years.

Courses I, II, and IV.

References: Howe, **Metallurgical Laboratory Notes.**

Sauveur and Boylston, **Laboratory Experiments in Metallurgy.**

Three hours a week during the first semester of the senior year.

Required in Group III.

(Haldane, Dittus.)

XI. METALLURGY. Lectures.

Credit five hours.

Gold and Silver. This course covers the following subjects: Metallurgy of gold and silver with special attention to stamp milling, cyanidation, and chlorination of gold ores; chloridizing

roasting, and amalgamation of silver ores; the Russell process and other wet methods for silver; the parting of gold and silver bullion by various commercial methods, with special attention to electrolysis and the sulphuric acid treatment. The various modifications of the cyanide process receive particular attention, especially the treatment of the slime for zinc precipitation; the Moore filter process; the regeneration of the cyanide; and the different methods proposed for precipitating the dissolved gold and the recent application of the cyanide process to silver ores.

Copper. A critical study of the principles of copper metallurgy as covered by the best modern practice, together with the roasting of ores, blast and reverberatory smelting, pyritic smelting, converting of matte, refining of copper, treatment of oxidized ores, and hydrometallurgical methods.

Prerequisites: The completed work of the freshman and sophomore years.
Courses I, II, and IV.

References: Rickard, **Stamp Milling of Gold Ores.**
Park, **The Cyanide Process.**
Julian and Smart, **The Cyanide Industry.**
Peters, **Modern Copper Smelting.**
Peters, **Principles of Copper Smelting.**

Five hours a week during the second semester of the senior year.

Required in Groups I, III, and IV.

(Traphagen.)

XII. METALLURGY. Laboratory.

Credit one hour.

This work includes the testing of gold ores by amalgamation, chlorination, and cyanidation; chloridizing roasting and amalgamation of silver ores; roasting and smelting of copper ores and products; tests of complex ores by dry chlorination and other methods; and the laboratory study of such processes as lend themselves to small scale treatment.

Prerequisites: The completed work of the freshman and sophomore years.
Courses I, II, and IV.

Three hours a week during the second semester of the senior year.

Required in Group III.

(Traphagen, Dittus.)

XIII. METALLOGRAPHY. Lectures.

Credit one hour.

This course comprises a study of the general methods of investigating metals and alloys; the determination of data and

plotting of cooling curves; the physical mixture, including a consideration of aqueous solutions, fused salts, and alloys; freezing point curves and diagrams; the preparation of the specimen, the development of the structure, and the use of the microscope.

Prerequisites: The completed work of the freshman and sophomore years.

Course IV.

References: Goerens, **An Introduction to Metallography.**
Ruer, **Elements of Metallography.**

One hour a week during the first semester of the senior year.

Required in Group III.

(Haldane.)

XIV. METALLOGRAPHY. Laboratory.

Credit one hour.

This course follows the lecture work and includes the study, under the microscope, of the steels, iron-carbon, and industrial alloys as influenced by various heat and mechanical treatments; mattes, speisses, base bullion, and other metallurgical furnace products. The micro-photographing of sections prepared is also used to further the laboratory study.

Prerequisite: Course XIII.

References: Goerens, **An Introduction to Metallography.**
Ruer, **Elements of Metallography.**

Three hours a week during the second semester of the senior year.

Required in Group III.

(Haldane.)

XV. ELECTROMETALLURGY. Lectures.

Credit two hours.

This course is divided into two parts. The first part covers the physical phase of the subject, and the second part the chemical phase.

1. The phenomena of electrolysis.
   (a) Measurements of the resistance and conductivities of electrolytes.
   Liquid and fused electrolytes.
   (b) Temperature effects.

Osmosis.

The principles underlying the transformation of electrical and chemical energy.

(a) Electromotive forces and heats of combinations.

(b) Thermo-electromotive effects.

Principles of electrical heating.

(a) Conduction and radiation.

(b) Efficiency of transformation of electrical energy into heat.

Two hours a week during the first half of the first semester of the senior year.

(Miller.)

2. (a) The description and use of various kinds of electrochemical apparatus.

(b) The principles involved in the estimation and separation of the more important elements and the chemical reactions which take place during electrolysis.

Two hours a week during the last half of the first semester of the senior year.

(Test.)

Prerequisites: The completed work of the freshman and sophomore years.
Course IV.

Required in Group III.

XVI. ELECTROMETALLURGY. Laboratory.

Credit one hour.

This course is intended to accompany Course XV.

1. The laboratory experiments in this part of the course are mainly of a physical nature and exemplify the principles presented in Part 1 of Course XV.

Three hours a week during the first half of the first semester of the senior year.

(Miller.)

2. Practice in the use of various kinds of electrochemical apparatus and the estimation and separation of the commoner metals, copper, mercury, silver, zinc, tin, antimony, arsenic, lead. iron, and cadmium.

Three hours a week during the last half of the first semester of the senior year.

(Test.)

Prerequisites: The completed work of the freshman and sophomore years.
Course IV.

Required in Group III.

XVII. ELECTROMETALLURGY. Lectures.

Credit three hours.

This course is divided into two parts and covers the following subjects:

(a) The electrolytic treatment of ores and refining of metals and the parting of gold and silver bullion. The recent

trend of metallurgy toward the electrical methods of treatment is marked. It is, therefore, the aim in this course to cover the principles of such treatment and to take up all processes in use or of commercial promise.

(b) Electric furnaces.

This is a course of lectures and recitations on modern practice in electric smelting, in which the various types of furnaces and their underlying principles are discussed and comparisons made with ordinary fire methods, followed by the direct application to the reduction of metals, the manufacture of carbide, carborundum, graphite, and other products.

Prerequisite: Course XV.

Three hours a week during the second semester of the senior year.

Required in Group III.

(Traphagen, Haldane.)

XVIII. METALLURGICAL PRACTICE. Laboratory.

Credit one hour.

This course consists of a laboratory study of principles, that is, the study of the free settling rate, slime settlement, estimation of the quantity and value of suspended slime, screen sizing, flotation, and similar studies. Laboratory and commercial sized machines receive very careful consideration. The machines are taken apart and a study is made of their construction and operation as pieces of mechanism.

Prerequisites: The completed work of the freshman and sophomore years.
Courses I, II, and IV.

Three hours a week during the first semester of the senior year.

Required in Groups I and III.

(Traphagen, Haldane, Dittus.)

XIX. METALLURGICAL PRACTICE. Laboratory.

Credit one hour.

This course covers a study of commercial sized machines and working tests in which the capacity, power, and water consumption are carefully considered. Working tests are run on various types of ore in which careful attention is given to sampling and to checking of results. The machines are first studied individually; their capacities, horse powers, water requirements and other such data are determined; after which they are regarded as parts of a system and working tests are carried on in which the function of each machine is critically determined.

The arrangement of the experimental plant is such that

various systems of treatment of the same ore may be tried and the results compared.

Prerequisite: Course XVIII.

This course is given in groups during the second semester of the senior year.

Required in Groups I and III.

(Traphagen, Haldane, Dittus.)

XX. ADVANCED GENERAL METALLURGY. (Postgraduate.)

Lectures and Laboratory.

Credit two hours.

This course comprises a study of metallurgical processes in the light of a good fundamental knowledge of the subject, with the object of gaining a thorough grasp of the underlying principles of metallurgical science. It covers the following subjects: Slag and slag formations suitable to different processes, their chemical properties, formation temperatures, melting points, and other properties; a detailed study of the metallurgy of copper, with particular reference to pyritic smelting and converting of copper matte; advanced work in the metallurgy of the precious metals, with special attention to ores difficult of treatment and to the use of recovery methods in the cyanide process.

One hour lecture and three hours laboratory a week with assigned reading during the second semester.

This course is intended primarily for postgraduates but may be taken by undergraduates with the consent of the instructor.

(Traphagen.)

XXI. ADVANCED METALLOGRAPHY. (Postgraduate.)

Lectures and Laboratory.

Credit two hours.

This course is an extension of Course XIII and involves a more thorough investigation of the theory of cooling curves and metallic alloys, after which some attention is given to the ternary alloys. The student is then given some individual problems to investigate.

Prerequisite: Course XIII.

One hour lecture three hours laboratory a week during the first semester.

This course is intended primarily for postgraduates but may be taken by undergraduates with the consent of the instructor.

(Haldane.)

XXII. METALLURGICAL PLANT DESIGN. (Postgraduate.)

Lectures and Drawing.

Credit two hours.

This work is a continuation of the work on power plants

and is intended to cover the design of a power plant for a concentrating, a cyanide, or a chlorination mill. The work on the part of the student comprises complete calculations to determine the number and sizes of units to suit the conditions imposed, the selection of machinery, and the layout of the plant. The student has access to many blue prints from manufacturing companies to facilitate his work. Sufficient detailed and assembled drawings are executed to insure the installation of the plant.

One hour lecture and three hours drawing a week during the second semester of the senior year.

This course is intended primarily for postgraduates, but may be taken by undergraduates with the consent of the instructor.

(Traphagen.)

GEOLOGY AND MINERALOGY.

Professor Horace Bushnell Patton.
Associate Professor G. Montague Butler.
Instructor Hyrum Schneider.

The school is very fortunately situated for the geologist. The surrounding formations not only present the strikingly clear features so characteristic of the West, but occur in great profusion and variety. In addition, certain features peculiar to this particular locality afford sufficiently complicated problems to be of great value to the student of geology. It is possible, therefore, without going more than a mile or two from the school to illustrate very effectively most geological problems so that field geology can be carried on at the same time with class instruction.

I. GENERAL GEOLOGY. Lectures.

The aim of this course is to present the fundamentals of geology in such a way that they can be readily understood by beginners and yet to present them fully enough to give those students who cannot pursue advanced courses, a fair general knowledge of the subject. The course is a study of physical geology and comprises a discussion of the composition of the earth, including a brief survey of rocks and rock minerals; the agencies internal and external which have in the past produced and are at present producing changes on the surface of the earth.

The basis of every science is laboratory work. The principal, in fact the fundamental, geological laboratory, is "The Great Outdoors." The region about Golden offers excellent opportunities for students to study geology at first hand. They can see and study for themselves in the field things that are discussed in the class room. A number of field trips are taken each semester. An outline of each trip, with suggestive questions to direct observations, is given to each student. Questions which students are unable to answer for themselves are answered by the instructor in charge of the trip. Written reports of these trips are required. The outlines of the trips with the questions are used as the basis of the reports. Besides the required field trips, a number of informal tramps are taken.

In connection with that part of the course which deals with rocks and rock minerals, each student is required to make an individual collection of at least fifteen different kinds of rocks. The rocks with a description, giving the general rock class to which each rock belongs, the specific name of each one and the reasons for the classification, must be submitted for correction

Prerequisites: Entrance requirements.

Text: Blackwelder and Barrows, **Elements of Geology.**

Three hours a week during the first semester of the freshman year.

Required of all students.

(H. Schneider.)

II. GENERAL GEOLOGY. Lectures.

This course is a continuation of Course I. It begins with a discussion of the principal plant and animal groups, which is followed by a discussion of the origin of the earth and its history from the beginning to the present time.

Prerequisite: Course I.

Text: Blackwelder and Barrows, **Elements of Geology.**

Three hours a week during the second semester of the freshman year.

Required of all students.

(H. Schneider.)

III. CRYSTALLOGRAPHY. Lectures and Laboratory.

This course is treated as an essential part of the general work in mineralogy. Only such portions of the subject are especially emphasized as are of practical value in the determination and proper understanding of minerals. A very thorough drill, however, is given in the more practical portions of the subject. This course is presented through lectures, text books, and practical laboratory work; also by individual quizzes. In the laboratory work each student is required to become thoroughly familiar with crystal forms and combinations such as are found on the usual wooden crystal models, and to determine with the aid of a pocket lens and contact goniometer the crystal forms of three hundred crystals.

Prerequisites: Chemistry I to VI, inclusive.

Text: Patton, **Lecture Notes on Crystallography.**

Lectures two hours laboratory six hours a week during the first eleven weeks of the sophomore year.

Required of all students.

(Patton, Butler, H. Schneider.)

IV. MINERALOGY. Lectures and Laboratory.

This course begins about the end of November with a drill for four weeks in the methods of blowpipe analysis, with a view

to preparing the student for the practical determination of minerals. This is followed by determinative mineralogy, which continues until the close of the second semester of the sophomore year. About two hundred fifty of the most important mineral species are presented by lecture, in which special emphasis is laid on the recognition of minerals by means of their physical properties and crystal forms. The object constantly kept in mind is not the training that will enable one to determine any mineral whatever, but rather to recognize at sight such minerals as are likely to be met in connection with mining operations. This is what the average mining engineer is expected to do. With this object in view, as thorough a drill as the time will allow is given in the actual handling and determining of minerals in the laboratory. In this work each student is expected to handle, to determine, and to be questioned and examined on approximately two thousand five hundred individual specimens.

Prerequisite: Course III.

Text: Butler, **Pocket Handbook of Blowpipe Analysis.**
Butler, **Pocket Handbook of Minerals.**

Lectures two hours laboratory six hours a week beginning about the end of November and continuing to the close of the second semester of the sophomore year.

Required of all students.

(Butler, Patton, H. Schneider)

V ADVANCED GEOLOGY. Lectures.

Credit five hours.

The object of this course is to train the student in the interpretation of geological phenomena and in the reading of earth history. No time is spent upon the more theoretical aspects of the science, such as are involved in physiographic and dynamic geology, but the practical application of the facts of stratigraphical and structural geology are emphasized. An outline of historical geology, with special reference to American areas, is presented, in which stress is placed upon the epeirogenic and orogenic movements, the economic products, the life systems, and the character of the rocks of the various geological time divisions. An effort is also made so to familiarize the student with the more important varieties of fossils that he may determine the age of any fossiliferous area. The work is given by means of lectures, laboratory work on fossils, and field trips.

Prerequisites: The completed work of the freshman year.

Five hours a week during the first semester of the junior year.

Required in Group IV.

(Butler.)

VI. LITHOLOGY. Lectures and Laboratory.

Credit three hours.

This is a lecture course supplemented by laboratory work. The object is to present all the more commonly occurring rocks in such a way as to render their identification at sight reasonably accurate. The methods pursued are purely those applicable to hand specimens without the aid of microscopic sections. The collection of the school is especially rich in those rocks that are usually met in mining operations in Colorado and adjacent states. Special emphasis, therefore, is laid upon such rocks and upon their various alteration forms.

Prerequisites: The completed work of the freshman year. Course IV.

Text: Kemp, **Handbook of Rocks.**

Lectures two hours laboratory three hours a week during the second semester of the junior year.

Required in Groups I and IV.

(Patton, Butler, H. Schneider.)

VII. FIELD GEOLOGY.

Credit three hours.

This course is designed to give a student practice in the various processes involved in preparing a complete geological map. The work covered includes, first, the preparation of a complete topographic map, including triangulation and contouring; second, the working out and mapping of the areal geology; third, the study of the economic features, such as ore deposits, that may be found on the territory surveyed. The area selected for study and mapping is usually some mining district in Colorado that has not been mapped and surveyed. The methods used in the preparation of the topographic map are mostly those that admit of rapid work and a degree of accuracy sufficient for most practical purposes.

Prerequisites: The completed work of the freshman and sophomore years.

Courses V and VI.

Six weeks during the summer between the junior and senior years and after the close of Mining III.

Required in Group IV.

(Patton, Butler, H. Schneider.)

VIII. FIELD GEOLOGY. (Elective.)

Credit one hour.

This is a briefer course than Course VII and is intended to give practice in the use of geological instruments and some practical familiarity with methods of topographic and geologic

mapping, as well as to train the student in correct geological observation.

Prerequisites: The completed work of the freshman and sophomore years.

This course is intended only for seniors.

Hours to be arranged.

(Patton, Butler, H. Schneider.)

IX. MICROSCOPIC PETROGRAPHY. Lectures and Laboratory.

Credit three hours.

In this course the study of rocks and rock-forming minerals is carried on with the help of the petrographic microscope. It covers (a) the study of the optical properties of minerals with a view to their identification, and (b) systematic petrography, or the identification of rock type by means of their structures and mineral components.

Prerequisites: The completed work of the freshman and sophomore years.
Course VI.

Lectures and laboratory six hours a week during the first semester of the senior year.

Required in Group IV.

(Patton.)

X. ORE DEPOSITS. Lectures.

Credit three hours.

This course treats of the nature, origin, and occurrence of ore deposits. Special attention is given to the ores which carry the more valuable metals, and to the more important mining camps of the West. The work is carried on principally by lectures with the aid of a text book.

Prerequisites: The completed work of the freshman and sophomore years.
Course VI.

Text: Ries, **Economic Geology.**

Three hours a week during the first semester of the senior year.

Required in Groups I and IV.

(Patton.)

XI. ECONOMIC GEOLOGY. Lectures.

Credit three hours.

This is a continuation of Course X, but takes up, in addition to a further discussion of metallic ore deposits, the more important non-metallic products and their sources.

Prerequisite: Course X.

Text: Ries, **Economic Geology.**

Three hours a week during the second semester of the senior year.

Required in Groups I and IV.

(Patton.)

XII. MINING GEOLOGY. Lectures.

Credit three hours.

This course aims to give the student the knowledge required for the solution of the many puzzling geological problems that confront mining engineers. Among the subjects discussed are the characteristics of the various types of ore deposits; criteria governing changes in the grade or character of the ore, both in vertical and horizontal directions; factors governing the vertical and horizontal extension of ore bodies; irregularities produced by faulting, folding, or the intrusion of igneous rocks; geology and physiography as an aid in prospecting. The features described are illustrated by many carefully chosen examples. The student is required to solve many practical problems by the application of the principles enunciated.

Prerequisites: The completed work of the freshman and sophomore years.
Courses V, VI, and X.

Three hours a week during the second semester of the senior year.

Required in Group IV.

(Butler.)

XIII. GEMS AND GEM MINING. (Elective.) Lectures and Laboratory.

Credit one hour.

This course is intended to give the student a proper realization of the economic importance of the gem industry and the knowledge required to turn this appreciation to practical account. Among the more important subjects discussed are the recognition and valuation, the cost and manner of cutting and mounting, the geographical distribution, the geological occurrence, and the manner of mining or collecting all grades of precious and semi-precious stones. In addition to the lecture and laboratory work, several trips are taken to the shops of Denver jewelers and lapidaries for work on the very valuable species, and to study the cutting and polishing of gems.

Prerequisites: The completed work of the freshman and sophomore years.

Lecture one hour laboratory three hours a week during the first semester of the senior year.

This course may be taken only with the consent of the instructor.

(Butler.)

XIV. CERAMIC GEOLOGY. Lectures, Laboratory, and Field Work.

Credit three hours.

This course is intended to enable the student to find, to classify properly, and to quarry or to mine the raw materials of the ceramic art. Emphasis is placed upon the geology of the subject rather than upon the details of manufacture of the clay products. Only the peculiar features and requirements of each line of manufacture are presented. The following subjects are discussed: Classification of clays and allied substances; their physical character; their recognition in the field and their distinctive properties; the necessary tests and chemical distinctions; the geological and geographical distribution of clays; the nature and cost of mining and quarrying operations; the value of, and market for, the various varieties; the uses of clays and the manufacture of clay products; obtaining government title to clay land; examining and reporting upon clay deposits.

Prerequisites: The completed work of the freshman and sophomore years.

Lectures two hours laboratory and field work three hours a week during the second semester of the senior year.

(Butler.)

Required in Group V.

XV. GEOLOGY OF THE NON-METALS. Lectures.

Credit three hours.

This course is concerned with practically all natural, non-metallic substances of any economic importance which are not fully covered elsewhere in the curriculum. The geological occurrence, geographical distribution, uses, and value of each substance are discussed, methods of mining are briefly described, and special emphasis is placed upon the physical and chemical characteristics which determine the values of the various products. Finally, the laws governing the acquisition of such substances are stated and full data concerning the marketing of the non-metals are given.

Prerequisites: The completed work of the freshman and sophomore years.
Courses IV, V, and VI.

Lectures three hours a week during the first semester of the senior year.

Required in Group V.

(Butler.)

XVI. GEOLOGIC AND TOPOGRAPHIC MAPS.
Lectures and Laboratory.

Credit two hours.

This course embraces essentially indoor field work and is

designed to assist the mining engineer in making a rapid interpretation of the geology of a region through its geologic map.

Prerequisites: Courses I, II, and V.

Six hours a week lecture and laboratory during the second semester of the junior year.

(H. Schneider.)

Required in Group IV.

CIVIL ENGINEERING.

Assistant Professor Harry Munson Showman.

The aim of this department is to develop the student along such lines in civil engineering as may be required of a mining engineer. This includes some knowledge of plane surveying, structural mechanics, structural design, and hydraulics.

I. PLANE SURVEYING. Lectures and Field Work.

Instruction is given by lectures, recitations, and field practice in the use and care of surveyor's instruments of precision. This work includes the adjustment of instruments; the theory and use of the barometer, planimeter, and plane-table; the principles and practice of land, city, topographical, and railroad surveying; and the determination of a meridian by observation on the sun and on circumpolar stars.

Prerequisites: Mathematics I and II.
Mechanical Engineering I and II.

Text: Tracy, **Plane Surveying.**

The entire work of this course is done during the six weeks which follow the close of the sophomore year.

Required of all students.

(Showman.)

II. MECHANICS OF ENGINEERING. Lectures.

Credit five hours.

This course consists of the theoretical study of mechanism and materials; the statics of a material point and of rigid bodies; chains, cords, and cables; stresses and strains; tension, shearing, compression; torsion, flexure; combined torsion and flexure; elastic curves; safe loads; oblique forces; long columns and continuous beams. The student becomes familiar with the fundamental ideas of the motions of bodies, initially treating the dynamics of a material point, with extensions of the theory to finite bodies. The fundamental differential equations of rectilinear motion are developed, and practical applications are found in the case of falling bodies, upward throw, and uniformly and variably accelerated bodies.

Prerequisites: The completed work of the freshman year.
Mathematics I to VI, inclusive.

Texts: Church, **Mechanics of Engineering.**

Church, **Notes and Examples in Mechanics.**

Five hours a week during the first semester of the junior year.

Required of all students.

(Showman.)

III. MECHANICS OF ENGINEERING. Lectures.

Credit five hours.

This is an extension of Course II. Virtual velocities introduce the first elements of the principles of work and energy and serve as a basis of discussion in the treatment of the curvilinear motion of a material point. Under this head the general equations and principles of curvilinear motion are derived and then applied to simple and cycloidal pendulums, to planetary motion, to a projectile in vacuo, to a body on smooth curved guide, and to absolute and relative velocities. A study is made of rotating bodies, compound pendulums, rudimentary engines, fly-wheels, eccentric pulleys, rolling bodies, parallel rod of locomotives, hoisting in mines, and kindred subjects. A brief study is made of the principles and applications of the graphic statics of mechanisms. The course concludes with work in hydrostatics, and takes up hydrostatic pressure, manometers. strength of pipe, pressures in tanks and against walls and dams, immersion and flotation, and the mechanical properties of gases.

Prerequisite: Course II.

Five hours a week during the second semester of the junior year.

Required of all students.

(Showman.)

IV. MECHANICS OF ENGINEERING. Laboratory.

Credit one hour.

In this course tests are made to determine the strength and stiffness of building materials such as cast-iron, wrought-iron, steel, plain and reinforced concrete, and wood in tension, compression, shearing, and flexure. Stone and brick are examined for strength, absorption, disintegration, and other qualities which decide their economic values. Tests of cement are made as specified by the American Society for Testing Materials.

Prerequisite: This course may be taken only in conjunction with Courses II or III.

Three hours a week during the first or the second semester of the junior year.

Required in Groups I and II.

(Showman.)

V. HYDRAULICS. Lectures.

Credit two hours.

The course opens with a brief review of hydrostatics as given in the latter part of Course III, takes up the theory and practical application of the properties of fluids in motion, and includes steady flow of liquids through pipes and orifices and over weirs; fluid friction and losses of head; time of emptying vessels; steady flow of water in open channels; impulse and resistance of fluids; pumps and rams; the impulse water motor; overshot, breast, and undershot water-wheels; back water; theorem for flow in a revolving pipe; turbine and reaction wheels, and theory of turbine testing.

Prerequisites: The completed work of the freshman and sophomore years.

Course III.

Texts: Church, **Mechanics of Engineering.**

Russell, **Text-book on Hydraulics.**

Two hours a week during the second semester of the senior year.

Required in Group I.

(Showman.)

VI. HYDRAULICS. Laboratory.

Credit one hour.

Measurements are made of the flow over weirs, through orifices, and through flumes and ditches. The determination of the approximate law of flow in pipes also forms part of the course. Water-wheels and centrifugal pumps are tested and the efficiency of the hydraulic ram under various conditions is determined.

Prerequisite: This course may be taken only in conjunction with Course V.

Three hours a week during the second semester of the senior year.

Required in Group I.

(Hazard.)

VII. ENGINEERING CONSTRUCTION. (Elective.) Lectures and Drawing.

Credit three hours.

In this course instruction is given in graphical analysis of the stresses of framed structures of the simpler forms. Comparison is made with the algebraic solutions of the same problems as far as practicable. The design of roof and bridge trusses in steel is then taken up from the theoretical and practical points of view. Steel mill buildings are thoroughly

discussed, an analysis of all stresses involved is made, and a complete design is required from each student. In connection therewith the forms, coverings, lighting, ventilation, erection, and similar topics are carefully considered. The design and construction of steel head-frames and ore bins are taken up in detail.

Prerequisites: The completed work of the freshman and sophomore years.

Course III.

Texts: Ketchum, **The Design of Mine Structures.**

Cambria Steel.

Miscellaneous References.

Lecture Notes.

Lectures and drawing eight hours a week during the first semester of the senior year.

(Showman.)

VIII. STRUCTURAL DETAILS. (Elective.) Lectures and Drawing.

Credit two hours.

This course is a study of the methods of framing heavy timber. The student is first made familiar with the terms of framing, such as housing, notching, mortise and tenon, dovetailing, lag-screws, dowels and lugs, and, from accepted unit stresses, he is led to design joints, splices, deepened beams, trussed beams, and head-frames from wood. A complete design of a combination wood and steel truss is required from each student. A brief study is made of the ordinary timbers used in construction and the best modern methods of protecting them from the action of the elements and wood-destroying insects.

Prerequisites: The completed work of the freshman and sophomore years.

Course III.

Texts: Jacoby, **Structural Details.**

Cambria Steel.

Miscellaneous references.

Lecture Notes.

Lectures and drawing six hours a week during the second semester of the senior year.

(Showman.)

MECHANICAL ENGINEERING.

Professor Ransom Smith Hawley.
Instructor Clarence Edwin Coolidge.
Instructor Claude Sylvester Johnson.

I. DESCRIPTIVE GEOMETRY. Lectures.

This course includes a study of elementary projection, simple problems relating to the point, line, and plane, methods of representation of simple solids, and the principles of freehand sketching.

Prerequisites: Entrance requirements.

Text: French, **Engineering Drawing.**

Two hours a week during the first semester of the freshman year.

Required of all students.

(Coolidge.)

II. ENGINEERING DRAWING. Drawing.

The object of this course is to give the student the fundamental principles of drafting according to modern drafting room and shop methods. Considerable time is devoted to freehand lettering, dimensioning, freehand sketching, and detail drawings of simple models.

Prerequisites: Entrance requirements.

Text: French, **Engineering Drawing.**

Nine hours a week during the first semester of the freshman year.

Required of all students.

(Coolidge, Johnson.)

III. ADVANCED PROJECTION. Lectures.

This is a continuation of Course I and includes advanced problems in projection, intersections of solids, development of surfaces, working drawings, and numerous practical applications of these principles to mine surveying and machine design.

Prerequisites: Courses I and II.

Text: French, **Engineering Drawing.**

Two hours a week during the second semester of the freshman year.

Required of all students.

(Coolidge.)

IV. ADVANCED ENGINEERING DRAWING. Drawing.

This course supplements the lecture course and includes the direct application and graphical solution of the problems that are studied in the lecture room.

Prerequisites: Courses I and II.

Text: French, Engineering Drawing.

Six hours a week during the second semester of the freshman year.

Required of all students.

(Coolidge, Johnson.)

V. MACHINE DESIGN. Lectures.

This course begins with the theoretical analysis of mechanism and extends to the practical application of these principles to such problems as arise in practice. Special attention is given to the analysis of links, belting, cams, gears, and other contact mechanisms.

Prerequisites: Courses III and IV.

Two hours a week during the first semester of the sophomore year.

Required of all students.

(Coolidge, Johnson.)

VI. MACHINE DESIGN. Drawing.

This course supplements and is directly dependent upon the lecture work. The work is taken up from a practical point of view and applies such theory as is consistent with the most approved method of design. Designs and complete working drawings are made of machine parts, gears, cams, and various systems and devices used for the transmission of power.

Prerequisites: Courses III and IV.

Three hours a week during the first semester of the sophomore year.

Required of all students.

(Johnson.)

VII. MACHINE DESIGN. Lectures.

This course is a continuation of Course V. A brief outline of the various principles of mechanics, so necessary for the work, is here taken up. Special attention is given to problems which involve the transmission of power and to the best solution of these from both the theoretical and practical points of view.

Prerequisites: Courses V and VI.

Two hours a week during the second semester of the sophomore year.

Required of all students.

(Coolidge, Johnson.)

VIII. MACHINE DESIGN. Drawing.

This course is a continuation of Course VI. The work is extended to include more complex problems. Complete working drawings of some of the following are submitted: Shafting layouts; belt, fibrous and wire rope drives; conveyors and conveying systems.

Prerequisites: Courses V and VI.

Three hours a week during the second semester of the sophomore year.

Required of all students.

(Johnson.)

IX. STEAM ENGINES AND BOILERS. Lectures.

Credit one hour.

The greater portion of the semester is devoted to steam boiler subjects. After a brief historical treatment of the subject, the lectures cover the theory, principles of design, and construction of modern boilers. Numerous practical problems are assigned from time to time so that the student becomes thoroughly familiar with the design and operation of the leading types of boilers.

Prerequisites: The completed work of the freshman year. Courses VII and VIII.

Text: Peabody and Miller, **Steam Boilers.**

One hour a week during the first semester of the junior year.

Required in Groups I, II, III, IV, and V.

(Hawley, Coolidge.)

X. STEAM ENGINES AND BOILERS. Drawing.

Credit two hours in Groups I and II.

Credit one hour in Groups III, IV, and V.

The drafting room work is devoted principally to the design of power plant apparatus and to such other machinery as is usually found in a mine plant. Boilers, steam engines, hoists, conveying systems, and mill installations are designed and complete sets of detail working drawings are required in all cases. The value of time is impressed upon the student and all work is done in accordance with the most approved manufacturing methods.

Prerequisites: The completed work of the freshman year. Courses VII and VIII.

Text: Peabody and Miller, **Steam Boilers.**

Six hours a week during the first semester of the junior year.

Required in Groups I and II.

Three hours a week during the first semester of the junior year.

Required in Groups III, IV, and V.

(Hawley.)

XI. STEAM ENGINES AND BOILERS. Lectures.

Credit two hours in Groups I and II.

Credit one hour in Groups III, IV, and V.

The lectures of this course embrace principally the subject of steam engines. The development of the steam engine is first carefully traced out, after which attention is given to thermodynamics and to the fundamental principles which underlie the steam engine. Practical problems are assigned to the student and great stress is laid upon all matters pertaining to the economical side of the subject.

Prerequisites: Courses IX and X.

Text: Ripper, **Steam Engine, Theory and Practice.**

Two hours a week during the second semester of the junior year.

Required in Groups I and II.

One hour a week during the second semester of the junior year.

Required in Groups III, IV, and V.

(Hawley, Coolidge.)

XII. STEAM ENGINES AND BOILERS. Drawing.

Credit one hour.

This course is a continuation of Course X and enables the student to undertake and complete some of the more advanced designs of power plant machinery.

Prerequisites: Courses IX and X.

Text: Ripper, **Steam Engine, Theory and Practice.**

Three hours a week during the second semester of the junior year.

Required in Groups I, II, III, IV, and V.

(Hawley.)

XIII. COMPRESSED AIR. Lectures.

Credit two hours.

This course includes a study of the theory and practice of air compression. At the beginning considerable time is given to the study of such principles of thermodynamics as are

necessary to a successful study of the course. After this the work comprises a study of single and multiple stage compression; absorption of heat during compression; transmission of power by compressed air; draining of moisture from pipe lines; reheating; the use of compressed air in motors and the various valve-gears used. A systematic study is made in the class room of the catalogues of one or more of the leading compressor builders.

Prerequisites: The completed work of the freshman and sophomore years.

Course XI.

Texts: Peele, **Compressed Air.**

Trade Catalogues.

Two hours a week during the first semester of the senior year.

Required in Groups I and II.

(Johnson.)

XIV. POWER PLANT DESIGN. Lectures.

Credit two hours.

This course includes a detailed study of the units and auxiliaries necessary to a power plant and their various connecting links. Problems affecting the type and location of power plants are taken up. The work is extended to problems which involve the best selection and number of units, location and arrangement, connection with auxiliaries, and the necessary housing for equipment. The items of first cost, operating cost, and depreciation are carefully considered.

Prerequisites: The completed work of the freshman and sophomore years.

Courses XI and XII.

Text: Gebhardt, **Power Plant Engineering.**

Two hours a week during the first semester of the senior year.

Required in Groups I and II.

(Hawley.)

XV. POWER PLANT DESIGN. Drawing.

Credit two hours.

The work in this course includes working drawings of some of the power plant equipment studied in detail in the lecture course. Such problems as the following are assigned: Detail of piping systems, including live and exhaust steam, for a certain sized plant; foundations for units and auxiliaries; flues and stacks; coal and ash handling machinery.

Prerequisites: The completed work of the freshman and sophomore years.

Courses XI and XII.

Texts: Gebhardt, **Power Plant Engineering.**

Trade Catalogues and Blue Prints.

Six hours a week during the first semester of the senior year.

Required in Groups I and II.

(Hawley.)

XVI. INTERNAL COMBUSTION ENGINES. (Elective.) Lectures.

Credit three hours.

This course is intended to give the mining engineer a practical working knowledge of internal combustion engines. The theory and thermodynamics of gas and oil engines are considered, together with conditions affecting efficiency and operation. The best types of modern engines are studied and discussed with regard to special features and advantages. Considerable time is devoted to practice in operating the engines in the laboratories of the school.

Prerequisites: The completed work of the freshman and sophomore years.

Course XI.

Text: Poole, **The Gas Engine.**

Three hours a week during the first semester of the senior year.

(Coolidge.)

XVII. PUMPING MACHINERY. (Elective.) Lectures.

Credit two hours.

This course comprises a careful study of the principle, design, and operation of all kinds of pumping machinery. Special attention is given to the selection and installation of steam, electric, and compressed air pumps for mine service. Problems involving the calculations of capacity, slip, and duty of pumping engines are assigned to the students. Considerable time is devoted to the study of air-lifts.

Prerequisites: The completed work of the freshman and sophomore years.

Course XI.

Text: Greene, **Pumping Machinery.**

Two hours a week during the second semester of the senior year.

(Johnson.)

XVIII. MECHANICAL ENGINEERING. (Elective.) Lectures and Laboratory.

Credit two hours.

It is the purpose of this course to familiarize the student with the theory and principles of the more important scientific apparatus used in engineering investigation. Much stress is laid upon the importance of accurate observations, correct interpretations of data secured through the use of laboratory equipment, and the correct form of engineering reports based upon the results of laboratory experiments. The work includes steam and gas engine indicator practice; the principle and operation of various reducing motions; absorption and transmission dynamometers; determination of the quality of steam; calibration of gages; valve setting; air meters; efficiency tests of steam and gas engines; efficiency and capacity tests of boilers; flue gas analysis; efficiency and capacity tests of air compressors; efficiency and capacity tests of small steam turbines.

Prerequisites: The completed work of the freshman and sophomore years.

Course XI.

Text: Carpenter, **Experimental Engineering.**

One hour lecture and three hours laboratory a week during the seond semester of the senior year.

(Hawley.)

XIX. MINE AND MILL PLANT DESIGN. (Elective.) Lectures and Drawing.

Credit three hours.

This work is a continuation of the course in power plants and is extended to cover the design of a power plant for a mine. The work in the lecture room begins with an analysis of the problems affecting the location of a typical plant and is extended to an analysis of the various departments of the plant and subsequently to the method of arriving at the power required by each under a particular case. Each student is assigned a problem that includes the design of a power plant for a certain character and size of mine. The work on the part of the student comprises complete calculations to determine the best number and sizes of units to suit the conditions imposed, the selection of machinery, and the layout of the plant. The drawings submitted include sufficient detailed and assembled drawings of the surface and underground plants so that the equipment can be installed. Blue prints of most of the equipment that is necessary for this work are kept on hand by the department or are secured from the various manufacturers.

Prerequisites: Courses XIV and XV.

Text: Gebhardt, **Power Plant Engineering.**

One hour lecture and six hours drawing a week during the second semester of the senior year.

(Hawley.)

XX. COAL TESTING. (Postgraduate.)

Credit one hour.

It is the purpose of this course to give the advanced student the opportunity of determining the adaptability and calorific value of the various kinds of coal found in this and in adjoining states by actually burning them under a boiler or in a gas producer. The equipment at the college affords special opportunity for carrying on such work

This course is intended primarily for postgraduates, but may be taken by undergraduates with the consent of the instructor.

(Hawley.)

XXI. MINE PLANT TESTING. (Postgraduate.)

Credit two hours.

This course is arranged with the idea of giving the student an opportunity to secure data by engineering methods from operating plants. The plants from which data are secured may be those of either coal or precious metal mines, or both. The tests may be conducted upon any one department of the plant or upon the plant as a whole. The work consists, for the most part, of determining the power used and efficiency of various makes of machinery for hoisting, pumping, air compression, generating electric light and power, conveying, ventilating, and for general shop purposes. The student takes the necessary apparatus in the field, sets it in place, and conducts the test in such a manner and for such a length of time as is necessary to obtain consistent engineering data. In order to carry on the work successfully, the student must be thoroughly familiar with the methods and apparatus used in conducting tests on power plants. The methods used may be summed up briefly as follows: Sampling and analyzing coals and gases; sampling and determining quality of steam; indicating reciprocating units; brake horsepower tests; valve setting; and metering steam, air, and electrical energy.

The proximity of the school to mining plants and metallurgical operations affords special opportunities and facilities for carrying on this work.

Lecture one hour laboratory three hours a week during one semester.

This course is intended primarily for postgraduates, but may be taken by undergraduates with the consent of the instructor.

(Hawley.)

ELECTRICAL ENGINEERING.

Professor William Jonathan Hazard.

I. DIRECT CURRENT MACHINERY. Lectures.

Credit three hours.

This course covers the operating principles of direct current machines, methods of connection, auxiliary apparatus used, field of usefulness of each type, and the calculation of circuits.

Prerequisites: Physics I to IV, inclusive.

Text: Franklin and Esty, **Elements of Electrical Engineering. Direct Currents.**

Three hours a week during the first semester of the junior year.

Required in Groups I, II, III, IV, and V.

(Hazard.)

II. DIRECT CURRENT MACHINERY. Laboratory.

Credit one hour.

In this work the common types of voltmeters, ammeters, and wattmeters are studied and calibrated, switchboards are drawn and used, and the common generators and motors, including the three-wire and interpole machines, are studied. Several forms of controllers are wired up and used.

Prerequisites: Physics I to IV, inclusive.

Reference books are furnished by the library.

Three hours a week during the first semester of the junior year.

Required in Groups I, II, III, IV, and V.

(Hazard.)

III. ALTERNATING CURRENT MACHINERY. Lectures.

Credit three hours.

The plan of this course is similar to that of Course I, but deals with alternating current machinery.

Prerequisites: Physics I to IV, inclusive.

Text: Franklin and Esty, **Elements of Electrical Engineering. Alternating Currents.**

Three hours a week during the second semester of the junior year.

Required in Courses I, II, III, IV, and V.

(Hazard.)

IV. ALTERNATING CURRENT MACHINERY. Laboratory.

Credit one hour.

A study is first made of the alternating current instruments which are subsequently used in the experimental work. This is followed by a variety of experiments on inductive circuits. Transformers are connected and used in a great variety of ways. The starting and running characteristics of induction motors are studied under normal conditions and under some abnormal conditions that are frequent causes of trouble. Synchronizing is done in several ways.

Prerequisites: Physics I to IV, inclusive.

Reference books are furnished by the library.

Three hours a week during the second semester of the junior year.

Required in Courses I, II, III, IV, and V.

(Hazard.)

V. SPECIAL APPARATUS AND APPLICATIONS. (Elective.) Lectures.

Credit three hours.

The object of this course is to afford an opportunity for the study of control and protective apparatus and for a closer study of typical installations than is possible in Courses I and III.

Prerequisites: Courses I to IV, inclusive.

Three hours a week during the first semester of the senior year.

(Hazard.)

VI. SPECIAL APPARATUS AND APPLICATIONS. (Elective.) Laboratory.

Credit one hour.

This course must be taken in conjunction with Course V. The experiments and tests follow the lecture work.

Prerequisites: Courses I to IV, inclusive.

Three hours a week during the first semester of the senior year.

(Hazard.)

VII. APPLIED ELECTRICITY. (Elective.) Lectures.

Credit two hours.

This course is an extension of Course V and deals with the practical problems of installation and operation of electrical apparatus.

Prerequisites: Courses I to IV, inclusive.

Two hours a week during the second semester of the senior year.

(Hazard.)

VIII. APPLIED ELECTRICITY. (Elective.) Laboratory.

Credit one hour.

The work of this course is an extension of Course VI and is given in conjunction with Course VII.

Prerequisites: Courses I to IV, inclusive.

Three hours a week during the second semester of the senior year.

(Hazard.)

CHEMISTRY.

Professor Herman Fleck.
Special Lecturer, Regis Chauvenet.
Assistant Professor Charles Darwin Test.
Assistant Professor John Christian Bailar.
Instructor George Stephen Tilley.

The courses in chemistry are arranged especially for the needs of mining, metallurgical, and chemical engineers. The demands made upon chemistry by these branches of engineering require a broad knowledge of inorganic chemistry, of the theories which underlie the science, and a close acquaintance with the properties of the elements, their reactions, detection, and separation. The various branches of organic chemistry are arranged for the courses in applied chemistry.

I. GENERAL CHEMISTRY. Lectures.

The course begins with a historical sketch of the development of the science of chemistry up to the atomic era. Thereafter history is introduced only as occasion demands. Although the course rests on a structure of inorganic chemistry, the development and application of modern theories and of organic chemistry are taught as the work advances through the nonmetallic elements during the first semester. Simultaneously a closer inspection of these elements is offered in the laboratory.

Prerequisites: Entrance requirements.

Text: Holleman, **Inorganic Chemistry.**

Lectures four hours recitation one hour a week during the first semester of the freshman year.

Required of all students.

(Fleck, Test, Bailar, Tilley.)

II. GENERAL CHEMISTRY. Lectures.

The second semester proceeds with the metals, which follow in the order of their periodicity, in accordance with the periodic law. Elementary metallurgy is introduced as the commercially important metals are considered.

Prerequisites: Entrance requirements.

Text: Holleman. **Inorganic Chemistry.**

Lectures four hours recitation one hour a week during the second semester of the freshman year.

Required of all students.

(Fleck, Test, Bailar, Tilley.)

III. QUALITATIVE ANALYSIS. Lectures.

The course treats of the theory of qualitative analysis and of special methods of identification. The Law of Mass Action and the Dissociation Theory are drawn upon for the former, and standard works and current literature supply the latter.

Prerequisites: Entrance requirements.
First half of Course I.

Texts: Prescott and Johnson, **Qualitative Analysis.**
School of Mines, **Qualitative Notes.**

Two hours a week from Thanksgiving till the end of the first semester of the freshman year.

Required of all students.

(Fleck, Test, Bailar, Tilley.)

IV. QUALITATIVE ANALYSIS. Lectures.

The course proceeds with the study of the metals, their detection and separation by special methods, and dwells particularly upon correct interpretation of the reactions involved and precautions necessary to obtain correct results. Details concerning the treatment of compounds, including minerals and mixtures, are entered into.

Prerequisite: Course III.

Texts: Prescott and Johnson, **Qualitative Analysis.**
School of Mines, **Qualitative Notes.**

Two hours a week during the second semester of the freshman year.

Required of all students.

(Fleck, Test, Bailar, Tilley.)

V. QUALITATIVE ANALYSIS. Laboratory.

The practice of manipulation and the study of the bases, their detection and separation, are begun.

Prerequisites: Entrance requirements.
First half of Course I.

Texts: Prescott and Johnson, **Qualitative Analysis.**
School of Mines, **Qualitative Notes.**

Six hours a week from Thanksgiving till the end of the first semester of the freshman year.

Required of all students.

(Fleck, Test, Bailar.)

VI. QUALITATIVE ANALYSIS. Laboratory.

The practice of manipulation and the study of the bases, their detection and separation, are continued. The acids are then taken up and treated after the manner of the preceding. More complex substances are given for analysis. The decomposition, solution, and examination of refractory substances follow.

Prerequisite: Course V.

Texts: Prescott and Johnson, **Qualitative Analysis.**
School of Mines, **Qualitative Notes.**

Twelve hours a week during the second semester of the freshman year.

Required of all students.

(Fleck, Test, Bailar, Tilley.)

VII. INDUSTRIAL CHEMISTRY. Lectures.

A broader acquaintance with industrial methods of chemistry, especially in the inorganic field, is essential in the education of the engineer. The course is intended to supply this by illustrated lectures on chemistry applied to the arts and to the apparatus used therein. Among the subjects considered are explosives and the raw materials used, which include sulphur, charcoal, potassium nitrate, nitric acid, sulphuric acid, glycerine, and ammonia.

Prerequisites: Courses I to VI, inclusive.

Two hours a week during the first semester of the sophomore year.

Required of all students.

(Bailar.)

VIII. INDUSTRIAL CHEMISTRY. Lectures.

The second semester continues with the following subjects: Fuels, clays, refractory materials, boiler compounds, and the alkali industry.

Prerequisites: Courses I to VI, inclusive.

Two hours a week during the second semester of the sophomore year.

Required of all students.

(Bailar.)

IX. QUANTITATIVE ANALYSIS. Lectures.

(Gravimetric.)

The work of the first semester begins with a consideration of the theories of solution, electrolytic dissociation, and mass action as applied to analytical chemistry. The determination and separation of the elements and important radicals are considered in detail. The aim of the course is to study the general

principles and methods of separation as used in quantitative analysis.

Prerequisites: Courses I to VI, inclusive.

One hour a week during the first semester of the sophomore year.

Required of all students.

(Test.)

X. QUANTITATIVE ANALYSIS. Lectures.

This is a continuation of Course IX.

Prerequisite: Course IX.

One hour a week during the second semester of the sophomore year.

Required of all students.

(Test.)

XI. QUANTITATIVE ANALYSIS. Laboratory.

(Gravimetric.)

The work begins with the analysis of simple salts. By this means the practice of manipulation and the observance of necessary precautions are learned. Gradually the analyses of substances of a more complex nature are introduced.

Prerequisites: Courses I to VI, inclusive.

Text: Cairns, Quantitative Analysis.

Six hours a week during the first semester of the sophomore year.

Required of all students.

(Fleck, Test, Bailar.)

XII. QUANTITATIVE ANALYSIS. Laboratory.

This is a continuation of Course XI.

Prerequisite: Course XI.

Six hours a week during the second semester of the sophomore year.

Required of all students.

(Fleck, Test, Bailar.)

XIII. QUANTITATIVE ANALYSIS. Lectures.

(Volumetric.)

Credit one hour.

This course consists of a study of methods of volumetric analysis. First, the theory of indicators and methods of acidimetry and alkalimetry are taken up. Later, the methods of determination of the more important substances are studied. Special attention is given to the principles of the methods used in smelter practice.

Prerequisites: Courses X and XII.

One hour a week during the first semester of the junior year.

Required in Groups III, IV, and V.

(Test.)

XIV. QUANTITATIVE ANALYSIS. Laboratory.

(Volumetric.)

Credit two hours.

This course covers the use of standard solutions and a study of the reactions involved. In due time the methods commonly used in metallurgical industries are introduced. A knowledge of the preparation of standard solutions and their uses is acquired by a course in acidimetry and alkalimetry. The preparation of standard solutions and their uses in the wet assays of ores and products which contain iron, manganese, lead, zinc, copper, and other metals, are practiced.

Prerequisites: Courses X and XII.

Six hours a week during the first semester of the junior year.

Required in Groups III, IV and V.

(Fleck, Test, Bailar.)

XVII. METALLURGICAL CHEMISTRY. Lectures.

Credit one hour.

The course undertakes a continuation of the principles involved in metallurgical laboratory practice.

Prerequisites: Courses XIII and XIV.

One hour a week during the second semester of the junior year.

Required in Group III.

(Fleck.)

XVIII. METALLURGICAL CHEMISTRY. Laboratory.

Credit two hours.

This is a continuation of Course XIV.

Prerequisites: Courses XIII and XIV.

Six hours a week during the second semester of the junior year.

Required in Group III.

(Fleck.)

XIX. METALLURGICAL CHEMISTRY. (Elective.) Laboratory.

Credit one hour.

Practice in laboratory work connected with the metallurgy of the less common and rare metals.

Prerequisites: Courses XVII and XVIII.

Three hours a week during the first semester of the senior year.

(Fleck.)

XX. COAL AND GAS ANALYSIS. Laboratory.

Credit one hour.

Prerequisites: The completed work of the freshman and sophomore years.

Three hours a week during the second semester of the senior year.

Required in Group II.

(Bailar.)

XXII. ADVANCED INDUSTRIAL CHEMISTRY. (Elective.) Laboratory.

Credit three hours.

In this course the student is given work in the preparation of cement mixtures, the blending of clays, the correction of impure clays, and in general the preparation of clays for various purposes.

Prerequisites: Courses I to XIV, inclusive.

Eight hours a week during the second semester of the junior year.

(Bailar.)

XXIII. RARE METALS. (Elective.) Lectures.

Credit two hours.

This course undertakes the study of the raw materials, occurrence, localities of occurrence, geology and mineralogy, metallurgy, finished products, uses, and outputs of the rare metals.

Prerequisites: Courses I to VI, inclusive.
Courses IX to XII, inclusive.

Two hours a week during the first semester of the senior year.

(Fleck.)

XXIV. RARE METALS. Laboratory.

Credit one hour.

Practice in the qualitative and quantitative analysis of rare metals, and of raw and finished products.

Prerequisites: Courses I to VI, inclusive.
Courses IX to XII, inclusive.

Three hours a week during the second semester of the senior year.

Required in Group V.

(Fleck.)

XXV. PHYSICAL CHEMISTRY. Lectures and Laboratory.

Credit two hours.

A course of laboratory practice in elementary physico-chemical measurements.

Prerequisites: Courses I to XIV, inclusive.
Courses XXVII to XXXIII, inclusive.

Lectures one hour laboratory three hours a week during the first semester of the senior year.

Required in Group V.

(Test.)

XXVI. ELECTROCHEMICAL ANALYSIS. Lectures and Laboratory.

Credit two hours.

The aim of this course is to give the student a practical knowledge of the electrochemical methods of analysis and the more common chemical reactions which take place under the influence of the electric current. That this object may be obtained, the course includes the estimation, by electrochemical means, of about fifteen of the more common metals and afterwards a separation of these metals. The principles are then applied to the analysis of minerals and smelting products. Later, experiments are taken up which illustrate the principles of oxidation and reduction, and a number of substances, the formation of which depends upon these principles, are prepared.

Prerequisites: The completed work of the freshman and sophomore years.

Lectures one hour laboratory three hours a week during the second semester of the senior year.

Required in Group V.

(Test.)

XXVII. STOICHIOMETRY. Lectures.

Credit one hour.

The course begins with the elements of the subject and includes a review of the first principles of theoretical chemistry, and finally extends to practical, metallurgical calculations. The work consists partly of individual computation by students so as to familiarize them from the beginning with the methods of actual calculation. The work extends into calculations of gas volumes, specific gravity, analytical calculations, and the elements of slag calculations in smelting operations.

Prerequisites: Chemistry I to VI, inclusive.
Chemistry IX to XII, inclusive.

One hour a week during the first semester of the junior year.

Required in Group V.

(Chauvenet.)

XXVIII. STOICHIOMETRY. Lectures.

Credit one hour.

This is a continuation of Course XXVII.

Prerequisite: Course XXVII.

One hour a week during the second semester of the junior year.

Required in Group V.

(Chauvenet.)

XXIX. ORGANIC CHEMISTRY. Lectures.

Credit three hours.

This course undertakes instruction in the general chemistry of the carbon compounds of the aliphatic series.

Prerequisites: Courses I to VI, inclusive.
Courses IX to XII, inclusive.

Three hours a week during the first semester of the junior year.

Required in Group V.

(Tilley.)

XXX. ORGANIC CHEMISTRY. Laboratory.

Credit two hours.

This course must be taken in conjunction with Course XXIX. Laboratory instruction in the preparation of typical organic compounds is given together with such synthetic reactions as are involved therein.

Prerequisites: Courses I to VI, inclusive.
Courses IX to XII, inclusive.

Six hours a week during the first semester of the junior year.

Required in Group V.

(Tilley.)

XXXI. ORGANIC CHEMISTRY. Lectures.

Credit two hours.

This is a continuation of Course XXIX in which the cyclic series is studied.

Prerequisites: Courses XXIX and XXX.

Two hours a week during the second semester of the junior year.

Required in Group V.

(Tilley.)

XXXII. ORGANIC CHEMISTRY. Laboratory.

Credit two hours.

This is a continuation of Course XXX together with ultimate analysis of carbon compounds.

Prerequisites: Courses XXIX and XXX.

Six hours a week during the second semester of the junior year.

Required in Group V.

(Tilley.)

XXXIII. INDUSTRIAL INORGANIC CHEMISTRY. Lectures and Laboratory.

Credit two hours.

This course covers a study of the analytical methods of inorganic industrial products such as gas, fertilizers, cements, acids, alkalies, and bleaching materials.

Prerequisites: Courses I to XII, inclusive.

Lecture one hour laboratory three hours a week during the second semester of the junior year.

Required in Group V.

(Fleck, Tilley.)

XXXIV. INDUSTRIAL ORGANIC CHEMISTRY. Laboratory.

Credit two hours.

Analysis of food stuffs, oils, fats, and waxes, tanning materials, and other materials of like nature.

Prerequisites: Courses I to XIV, inclusive.
Courses XXVII to XXXIII, inclusive.

Six hours a week during the first semester of the senior year.

Required in Group V.

(Fleck, Tilley.)

XXXV. THEORETICAL CHEMISTRY. Lectures.

Credit one hour.

This course includes lectures on the history of chemistry, the development of the science in the nineteenth century, the present aspect of chemical theories, recent advances in synthetical products, and advanced work in stoichiometry.

Prerequisites: The completed work of the freshman and sophomore years.

One hour a week during the first semester of the senior year

Required in Group V.

(Chauvenet.)

XXXVI. THEORETICAL CHEMISTRY. Lectures.

Credit one hour.

This is a continuation of Course XXXV.

Prerequisites: The completed work of the freshman and sophomore years.

One hour a week during the second semester of the senior year.

Required in Group V.

(Chauvenet.)

XXXVII. TECHNOLOGY OF THE NON-METALS. Lectures.

Credit two hours.

This course considers the methods employed in the preparation of commercial products from the raw materials. Among the subjects discussed are asbestos, barite, borax, dolomite, fluorite, gypsum, infusorial earth, limestone, magnesite, ochre, phosphate rock, sandstone, and shale.

Prerequisites: The completed work of the freshman and sophomore years.

Two hours a week during the first semester of the senior year.

Required in Group V.

(Bailar.)

PHYSICS.

Professor Louallen Frederick Miller.
Fellow Edmund Mills Field.

In arranging the courses of this department the aim is to present thoroughly those physical principles and theories which are fundamental to all engineering subjects. It is also intended to prove the validity of the various physical laws, and to show that they are bound together by exact mathematical relations. Many experiments accompany the lectures in order to demonstrate the practical relation of physics to engineering. Numerous problems are assigned in class which give each student experience in making practical applications of these laws and principles to engineering problems. In the laboratory each student is required to verify quantitatively the laws and principles developed in the lectures.

I. GENERAL PHYSICS. Lectures.

This course consists of lectures, illustrated by experiments, and recitations with assigned problems. The subjects treated are mechanics, including the elements of kinematics, dynamics, and hydrostatics; the properties of matter; heat, including thermometry and expansion, calorimetry, change of state, conduction, radiation, and the elements of thermodynamics; sound, including wave motion in general, production and propagation of sound waves, pitch, reflection, refraction, interference, and resonance.

Prerequisites: Mathematics I to IV, inclusive.

Text: Franklin and MacNutt, **Text Book of Physics.**

This course must be preceded by or taken in conjunction with Mathematics V.

Three lectures and two recitations a week during the first semester of the sophomore year.

Required of all students.

(Miller.)

II. PHYSICS. Laboratory.

This course is arranged to accompany Course I. Its aim is to teach the student the necessity of careful work as well as to acquire skill in physical measurements so that the important physical laws can be quantitatively verified.

Prerequisites: Mathematics I to IV, inclusive.
Physics I must be taken in conjunction with this course.

Text: Reed and Guthe, **A Manual of Physical Experiments.**

Four hours a week during the first semester of the sophomore year.

Required of all students.

(Miller, Field.)

III. GENERAL PHYSICS. Lectures.

This course is a continuation of Course I. The subjects treated are light, including propagation, reflection, refraction, dispersion, interference, emission, absorption, and polarization; electricity and magnetism, including electrostatics, electrokinematics, thermo-electricity, magnetic induction, electro-magnetism, electrolysis, the electro-magnetic theory, and electric oscillations; conduction of electricity through gases, and radioactivity.

Prerequisite: Course I.

Text: Franklin and MacNutt, **Text Book of Physics.**

Three lectures and two recitations a week during the second semester of the sophomore year.

Required of all students.

(Miller.)

IV. PHYSICS. Laboratory.

This course is a continuation of Course II.

Prerequisite: Course II.

Physics III must be taken in conjunction with this course.

Text: Reed and Guthe, **A Manual of Physical Experiments.**

Four hours a week throughout the second semester of the sophomore year.

Required of all students.

(Miller, Field.)

V. RADIOACTIVITY AND SPECTROSCOPY. (Elective.)

Credit two hours.

In radioactivity, a study is made of radioactive substances and the theory of the phenomena. Experiments are given in the measurement of radioactivity and its detection in ores.

In spectroscopy, a study is made of the theory and use of the spectroscope, after which the measurements and determinations of the spectra of the various metals are made. The detection of rare metals in ores is made a feature of the course.

Prerequisites: The completed work of the freshman and sophomore years.

Six hours a week during the second semester of the senior year.

(Miller.)

MATHEMATICS.

Professor Charles Roland Burger.

Assistant Professor George Eulas Foster Sherwood.

(On leave of absence, 1912-13.)

Instructor Ilo Ivan Taylor.

The courses in this department have been arranged to meet the extensive needs of students in the various branches of engineering. The subjects are treated so as to give the student both logical training and power of application. The principles which are of greatest value in engineering work are particularly emphasized. The courses offered serve as a sufficient prerequisite for the work in mathematical physics, physical chemistry, engineering, and applied mechanics. They mark the minimum of mathematical attainments that an engineer ought to possess. A special feature of the work is the early introduction of the calculus, the principles of which are introduced with those of analytic geometry and developed as needed. The instruction thus disregards, to a certain extent, the traditional barrier that has existed between these subjects. By this means, the principles of the calculus are allowed to develop slowly, their sphere of usefulness is widened, the student gains a better grasp of mathematics as a whole, and is able, early in his course, to make direct application of his knowledge of mathematics to practical problems.

I. COLLEGE ALGEBRA.

This course begins with a rapid review of the fundamental operations as far as quadratics. Graphic work is early introduced in the belief that the illumination which it affords greatly enlivens the entire presentation of the subject and brings algebra into closer relationship with the other mathematical courses. Quadratics are given special emphasis. The progressions, inequalities, mathematical induction, proportion, variation, theory of limits, series, the binomial theorem, logarithms, exponentials, complex numbers, permutations, combinations, the theory of probability, and determinants are all amply treated. Those propositions of the theory of equations which lead up to the various methods of approximating the roots of numerical equations are especially emphasized.

Prerequisites: Entrance requirements.

Text: Rietz and Crathorne, **College Algebra.**

Five hours a week during the first semester of the freshman year.

Required of all students.

(Taylor.)

II. TRIGONOMETRY.

The general formulas of plane and spherical trigonometry are developed. Inverse functions, identities, and trigonometric equations are carefully considered. Much practice is given in the use of tables and the applications of trigonometry to mensuration in general. The astronomical triangle and such problems relating thereto as occur in surveying are dwelt upon particularly. Graphical representation is given its needed emphasis.

Prerequisites: Entrance requirements.

Texts: Hun and MacInnes, **Plane and Spherical Trigonometry.**
Hodgman, **Surveyor's Tables.**

Three hours a week during the first semester of the freshman year.

Required of all students.

(Burger, Taylor.)

III. ANALYTICAL GEOMETRY.

This course begins with the geometry of the point, the straight line, and the circle. The conic sections are studied from the equation derived from the general definition. The general equation of the second degree, with the term in xy wanting, is then taken up and from this the special forms relating to the ellipse, hyperbola, and parabola are deduced. A thorough discussion of the most general equation follows. The methods and notation of the calculus are introduced early and are employed in the study of tangents and normals. The parametric equations of the conics and cycloids are developed and many applications to locus problems are introduced and discussed. The student is made familiar with the polar equations of the conics, spirals, ovals, and other plane curves. Emphasis is given to the graphical representation of the trigonometric, logarithmic, exponential, and other transcendental functions. The analytic geometry of space is deferred until the second year when it is needed in the development of the calculus.

Prerequisites: Courses I and II.

Text: Riggs, **Analytic Geometry.**

Five hours a week during the second semester of the freshman year.

Required of all students.

(Taylor.)

IV. CALCULUS.

This course introduces the student to the elements of the calculus. The language, the symbols, and the first processes of the infinitesimal analysis are explained. Many illustrations in geometry, physics, engineering, and applied mechanics are introduced. The fundamental principles of continuity, limiting values, and the theory of infinitesimals are established. The differentiation of all the fundamental forms and the application of the differential calculus to problems involving maxima and minima, rates, and to the theorems of analytic geometry comprise a large part of the course. Integration is introduced as the inverse operation of differentiation and is applied to numerous problems which involve areas, velocities, and geometry.

Prerequisites: Courses I and II.

Text: Davis, **The Calculus.**

Three hours a week during the second semester of the freshman year.

Required of all students.

(Burger, Taylor.)

V. CALCULUS.

This course is a continuation of Course IV, in which students are made familiar with the elementary processes and applications of the differential calculus. A special feature of this course consists in carrying on the differential and integral calculus together. This method of instruction enables the student to grasp the more difficult notions of the subject in their inherent relations, and at the same time to apply this knowledge, early in the course, to the solution of engineering problems. The conception of the definite integral and its many applications are early introduced. The aim is to make clear the rationale of each process, and to arouse an early interest in the usefulness of the subject. The theory of single and multiple integration is applied to the principal methods of rectification and quadrature, and to the calculation of surfaces and volumes of solids of revolution.

Prerequisites: Courses I to IV, inclusive.

Text: Davis, **The Calculus.**

Five hours a week during the first semester of the sophomore year.

Required of all students.

(Burger.)

VI. CALCULUS.

This course is a continuation of Course V. The elements of solid analytic geometry are introduced to assist in the proper development of the calculus of functions of two or more variables. Simple differential equations are introduced in close

connection with integration. Multiple integration in rectangular, polar, and cylindrical co-ordinates is taken up and many applications are made to problems in areas, volumes, moments of inertia, centers of gravity and pressure. Solids of revolution, cylinders, space curves, ruled and quadric surfaces are all given their needed emphasis as applications of the calculus.

The last part of this course is pre-eminently a problem course. The aim is to review, in a practical way, the mathematics of the two previous years and thereby to encourage the student to look upon his mathematics as an instrument of power and usefulness rather than one merely of mental development and culture.

Prerequisites: Courses I to V, inclusive.

Text: Davis, **The Calculus.**

Five hours a week during the second semester of the sophomore year.

Required of all students.

(Burger.)

VII. PRACTICAL ASTRONOMY. (Postgraduate.)

Credit two hours.

This course covers a study of the heavenly bodies; their mutual relations; their motions, forms, dimensions, and physical constitution; the relation of the earth to the heavens; the theory of the determination of time, latitude, longitude, and azimuth; attraction of the moon; tides; mass and density of the earth; problems of gravitation; astronomical instruments and their mathematical theory.

Two hours a week during the first semester.

This course is intended primarily for postgraduates, but may be taken by undergraduates with the consent of the instructor.

(Burger.)

VIII. PRECISE SURVEYING AND GEODESY. (Postgraduate.)

Credit two hours.

This course covers an introduction to the method of least squares; precise plane triangulation; base lines, standard tapes, correction for temperature, sag, and pull; precise leveling; spherical and spheroidal geodesy; plumb line deflections; convergence of meridians; running parallel arcs; geodetic coordinates and map projections; reconnaissance; adjustments of triangles and quadrilaterals; the construction and use of tables.

Two hours a week during the second semester.

This course is intended primarily for postgraduates, but may be taken by undergraduates with the consent of the instructor.

(Burger.)

ENGLISH.

President Victor Clifton Alderson.

I. ENGLISH. Lectures.

Credit one hour.

The purpose of this course is to train the students to use clear, accurate, and simple English. Weekly themes are required, which are carefully corrected and returned.

Prerequisites: The completed work of the freshman year.

One hour a week during the first semester of the junior year.

Required of all students.

(Alderson.)

II. ENGLISH. Lectures.

Credit one hour.

This is a continuation of Course I.

Prerequisites: The completed work of the freshman year.

One hour a week during the second semester of the junior year.

Required of all students.

(Alderson.)

III. ENGLISH. Lectures.

Credit one hour.

This is a continuation of Course II.

Prerequisites: The completed work of the freshman and sophomore years.

One hour a week during the first semester of the senior year.

Required of all students.

(Alderson.)

IV. ENGLISH. Lectures.

Credit one hour.

This is a continuation of Course III.

Prerequisites: The completed work of the freshman and sophomore years.

One hour a week during the second semester of the senior year.

Required of all students.

(Alderson.)

MINING LAW.

Special Lecturer, Frederick S. Titsworth.

I. MINING LAW. (Elective.)

Credit one hour.

Beginning with a historical review of the growth of our present laws relating to mining, the course aims to cover every feature of general interest to the practicing mining engineer.

Prerequisites: The completed work of the freshman and sophomore years.

One hour a week during the first semester of the senior year.

(Titsworth.)

INSPECTION TRIPS.

The same importance is attached to the inspection trips as to class room and laboratory work. Grades are given on reports submitted and satisfactory results are required.

SENIOR TRIP.

At the conclusion of the senior year an extended trip, lasting about a month, is made to important centers in Colorado, Utah, and Montana for advanced work in geology, metallurgy, mining, and engineering. Detailed work is assigned to each student. The results of his observations and investigations are carefully written and these are criticised by his instructors. Six professors accompany the class and maintain the same high standard of study that is required at Golden. Private sleeping cars, day coach, and baggage car are chartered for the trip. Everywhere the greatest courtesies are received. Not only are the plants thrown open for inspection, but members of their staffs are detailed as guides. Many students secure good positions during the trip and form acquaintances that are apt to be of value to them later.

ITINERARY.

COLORADO.

PORTLAND.

Metallurgy.

Colorado Portland Cement Company; crushing and fine grinding of raw material and clinker.

CANON CITY.

Metallurgy.

Empire Zinc Company; wet and magnetic separation of zinc ores and magnetic treatment of Wilfley table middling; experimental plant with magnetizing roaster, magnetic separators, dry and electrostatic separators, and Elmore installation.

United States Smeltery; pigment smelting of complex zinc-lead ore, and the working of the product into a marketable form.

Mining.

Coal Mines; the Canon City coal field is famous as a producer of high grade domestic coal and is one

of the few districts in the United States where long-wall mining is practiced.

Geology.

A study is made of the mesozoic sedimentary formations that are upturned in fine hog-backs in a great semicircle around the Canon City basin.

LEADVILLE.

Metallurgy.

Arkansas Valley Plant of the A. S. and R. Company; lead smelting; Ropp, Brown-Horseshoe, Godfrey, and H. and H. roasting; briquetting, and blast furnace treatment of silver-lead ore.

Geology.

The paleozoic series and fault systems as well as the ore bodies are studied underground. The sharply defined moraines, and other glacial phenomena on the surface are also studied.

SHOSHONE.

Engineering.

Central Colorado Power Company, hydro-electric plant. Water from the Grand river is conducted through a tunnel cut into the mountain for approximately two and one-quarter miles, delivered through penstocks to central discharge turbines under a head of 165 feet; capacity of plant 21,000 h. p.; transmission voltage 100,000.

SHOSHONE AND GLENWOOD SPRINGS.

Geology.

Archaean gneisses and schists, and unconformable above these the paleozoic rocks are exposed in the canyon of the Grand river; typical canon erosion and travertine deposits. At Glenwood Springs are the mesozoic rocks.

UTAH.

BINGHAM.

Mining.

This district permits the study of three distinct systems of mining, namely, the overhead stoping, the caving, and the open pit. The extensive properties of the Utah Consolidated Mining Company and the Utah Copper Mining Company are open to the unrestricted inspection of the class. Further interest in this district comes from the opportunity to study aerial tram systems, difficult

railroad engineering, and the operations of single companies under different systems.

Geology.

The carboniferous quartzite and limestone, with intruded igneous masses that have marmorized the limestone at contact; the relationship of the ore bodies to these contact phenomena.

BINGHAM JUNCTION.

Metallurgy.

United States Smelting Company; special roasting devices for lead ores, with neutralization and bag-housing of fumes; Huff electrostatic concentration plant for the treatment of zinc-iron middling.

GARFIELD.

Metallurgy.

Utah Copper Company; Arthur and Magna mills; roll crushing of Bingham ore with jigging, tabling, and vanning methods of concentration; Garfield tables and Richards-Janney classifiers.

Engineering.

Utah Copper Company; steam power plant; capacity 10,000 boiler h. p.; 500 h. p. Heine boilers equipped with underfeed stokers; forced draft; concrete stacks; large cross compound Allis and Nordberg engines direct connected to alternating current generators; Wheeler surface condensers with independently driven Edwards air pumps.

American Smelting and Refining Company; steam power plant; large horizontal blowing engines; single stage air compressors driven by cross compound Corliss engines; Worthington surface condensers with Blake air and circulating pump; 500 h. p. Stirling boilers equipped with plain grates.

SALT LAKE CITY.

Metallurgy.

General Engineering Company; special devices for screening, classifying, and concentrating ore.

Geology.

Excursion into the Wasatch range; the great synclinal fold and the Wasatch fault; very recent faults and glacial features; Lake Bonneville terrace formations.

PARK CITY.

Metallurgy.

Daly-Judge, Daly-West, and Silver King mills; wet concentration of zinc-lead-silver ore; special sampling, crushing, and classifying devices.

Grasseli mill; dry concentration of table middling; Keedy sizers, and Sutton, Steele and Steele dry tables.

Mining.

Daly-Judge, Daly-West, and Silver King mines; method of handling ore in flat, narrow seams; large square set stopes.

MONTANA.

BUTTE.

Metallurgy.

Butte and Superior mill; concentration of Black Rock zinc ore by jigging and tabling, with oil flotation of the fine sulphide.

The precipitation plants; recovery of dissolved copper from mine water; leaching and recovery of soluble material from dumps.

Mining.

The mines of this district exhibit modern practices of lode mining in high grade copper ore. Among the noteworthy mining features studied are deep mining with the involved difficulties of drainage, ventilation, and timbering; steel surface structures; automatic loading and dumping of ore; rapid hoisting; mechanical framing of timber; handling of large volumes of acid water; square set stoping; the driving of working levels in country rock; the naturally high temperatures of the working places; and the systematic recording of every operation. Mine surveying and underground geology are exemplified in the practices of the Amalgamated Copper Company.

Geology.

Secondary enrichment of original sulphide ores; the relationship of these ore bodies to the remarkable fault systems of Butte; the study of granite, aplite, porphyry, and rhyolite rocks.

Engineering.

Amalgamated Copper Company; mine plant at the New Leonard; 3,500 h. p. Nordberg hoist; 150 foot

steel head frame; two stage Nordberg air compressors, rope driven by induction motors; locomotive type of boilers.

Amalgamated Copper Company; mine plants at the Diamond and Bell mines; large air compressor plant; two stage compressors equipped for either steam or motor drive; 3,000 h. p. Allis hoisting engine; marine type of boilers; high steel head frame with automatic dumping attachments.

ANACONDA.

Metallurgy.

New Reduction Works; track system for the delivery of ores and shipment of products; compressed air traction for yard haulage; concentrating mill of eight one-thousand ton units; bin systems; briquetting plant; largest furnaces in the world; reverberatory furnaces; converter plant; refining furnaces and casting department; arsenic plant, and flue systems; Peck centrifugal concentrator; Laist deslimer; new plant for the treatment of fine material with four-deck round tables; roasting-leaching treatment of tailing. So much is to be seen here that more time is spent in this plant than at any other point, and, because of the courtesy of the management, much valuable instruction is possible.

The Anaconda Copper Mining Company; brick department; the manufacture of clay and silica brick of many shapes and of the highest degree of refractoriness.

Engineering.

New Reduction Works; general power plants; large triple expansion condensing Corliss engines belted to line shaft; two and four stage air compressors driven by cross compound Corliss engines; rotary blowers of the Connersville and Root types, direct connected to Corliss engines; rotary blowers, rope driven from induction motors; Stirling boilers equipped with plain grates; rotary converters and transformers for the high tension current brought in from the hydro-electric plants; 2,400-volt d. c. apparatus for the B. A. and P. electrification.

MINING TRIPS.

During the junior and senior years, the students are taken to well known Colorado mining districts for the inspection of actual mining operations. These trips are arranged in such order as to introduce different interesting features and, at the same time, to emphasize definite portions of the class room instruction. Attention is paid to surface plants, underground equipment, mining systems, and to all the regular operations, both above and below ground. Lectures precede these trips to explain their objects, the particular properties to be visited, and the operations to be witnessed. Printed outlines are furnished and each student is required to submit a report, illustrated by his own sketches.

CENTRAL CITY AND IDAHO SPRINGS.

This trip is taken about the middle of the junior year and lasts two days. It includes a study of the mining methods and plants in the narrow veins of the Clear Creek district and the inspection of the long drainage tunnels. The Newhouse tunnel is approximately four miles long and is one of the most famous in the world for mine drainage and transportation.

Required of all students taking Mining VIII.

LEADVILLE AND BRECKENRIDGE.

This trip, taken near the close of the junior year, gives the students an opportunity to study the methods of mining the massive deposits for which Leadville is noted. Underhand and overhand stoping with square sets is seen. At Breckenridge three modern placer dredges are in use, besides hydraulic and steam shovel operations. The lode mines of this district are also visited. During this trip considerable time is spent studying mechanical and electrical engineering features, such as power plants, electric and steam hoisting plants, and high tension electric sub-stations.

Required of all students taking Mining VIII.

CRIPPLE CREEK.

In the Cripple Creek district the students go underground in two or more mines to study mining and transportation methods and make an extended study of the surface plants with complete tests of hoists and steam plants. The Roosevelt drainage tunnel and the methods of handling and treating the enormous low grade ore dumps are studied.

Required of all students taking Mining X.

NORTHERN COAL FIELDS. (First Trip.)

This trip is completed in one day and is intended to give the students an opportunity to observe the method of working coal mines by the room-and-pillar method and the getting of tbe coal to the surface.

Required of all students taking Mining VIII or Mining XII.

NORTHERN COAL FIELDS. (Second Trip.)

This trip covers detailed studies of ventilation, hoisting, and haulage systems. Different mines are visited. This trip differs from the first in that greater stress is laid upon details.

Required of all students taking Mining XIV.

SOUTHERN COAL FIELDS.

This trip includes a thorough inspection of the mines and surface plants of the Trinidad coal area. Methods of mining on flat and steeply pitching veins and the various arrangements of tipples are studied. Considerable attention is given to coking plants, as one of the largest batteries of bee hive ovens in the world is at Secundo. Coal washing methods and plants are also studied.

Required of all students taking Mining XII.

Industrial Chemistry Trips.

A trip is made to the plant of the Western Chemical Manufacturing Company, Denver, to study the methods used in the manufacture of sulphuric acid and the chemicals that are usually manufactured in connection with sulphuric acid.

Required of all students taking Chemistry VII.

A trip is made to the gas plant of the Denver Gas and Electric Company for a general study of the manufacture of artificial fuels and the treatment of by-products.

Required of all students taking Chemistry VIII.

A trip is made to the plant of the Golden Pressed and Fire Brick Company to study the methods used in the manufacture of refractories.

Required of all students taking Chemistry VIII.

Electrical Plant Trips.

Near the end of the junior year trips are made to the generating stations and sub-stations in and about Denver, where nearly all the electrical machinery studied during the year can be seen in commercial use.

Required of all students taking E. E. III.

Mechanical Power Plant Trip.

Near the close of the junior year a trip is made to several of the steam power plants in and near Denver. Particular atten-

tion is given to steam boiler and engine installations and operations which have been studied during the year.

Required of all students taking M. E. XI.

METALLURGICAL TRIPS.

The pyritic smeltery of the North American Smelter and Mines Company at Golden is visited for a study of furnaces and ore sampling. The Minnequa plant of the Colorado Fuel and Iron Company at Pueblo, Colorado, is visited for a study of the manufacture of iron and steel and the working up of the product into commercial forms.

Required of all students taking Metallurgy III.

The Pueblo and Globe plants of the Americau Smelting and Refining Company are visited for a study of the metallurgy of lead and of systems of sampling and handling ore and products.

The United States Zinc Company plant, of the American Smelting and Refining Company at Blende, Colorado, is visited for the metallurgy of zinc and the manufacture of retorts.

Required of all students taking Metallurgy IV.

The Jackson, Newton, Hudson, and other mills at Idaho Springs, and the Frontenac mill at Black Hawk are visited for a study of concentration. The stamp mills at Central City and at Black Hawk are visited for amalgamation.

The ore testing plant of Henry E. Wood and Company, in Denver, is visited for various methods of ore treatment especially flotation by Mr. Wood's device and by the Elmore oil-acid-vacuum method.

The experimental plant of the American Zinc Ore Separating Company in Denver, is visited for electrostatic and pneumatic concentration.

Required of all students taking Metallurgy VII.

The Portland mill at Colorado Springs is visited for a study of chlorination and of cyanidation with filter press separation of solution and solids, and zinc dust precipitation of precious metals from solution.

The Golden Cycle mill at Colorado City is visited for cyanidation of Cripple Creek ore by roasting followed by leaching of the sand and agitation of the slime. Butters filters and zinc shaving precipitation are used here.

The Victor, Independence, and Ajax mills at Cripple Creek, which use various methods in the concentration-cyanidation treatment of low grade telluride ores and dump material, are visited.

Required of all students taking Metallurgy XI.

GENERAL INFORMATION.

EXPENSES.

TUITION.

The Statutes of Colorado provide as follows:

"The said School of Mines shall be open and free for the instruction to all bona fide residents of this State, without regard to sex or color, and, with the consent of the Board, students from other states and territories may receive education thereat upon such terms and at such rates of tuition as the Board may prescribe."

The tuition for non-residents is one hundred fifty dollars a year, payable in two installments—seventy-five dollars at the beginning of each semester.

DEPOSITS.

Deposits are required to cover the cost of supplies consumed. Any unused balance is returned.

For each chemical laboratory course	$15.00
For Metallurgy II	25.00
For Metallurgy XVIII	5.00
For Metallurgy XVI	5.00
For drawing (paid once only)	2.00

FEES.

Fees are charged to cover not only the cost of materials and supplies furnished but also the wear on apparatus. No part of a fee is returnable. The athletic fee, although collected by the school, is turned over to the Treasurer of the Athletic Association and is expended only for athletic purposes.

GENERAL FEES.

Matriculation fee	$ 5.00
Athletic fee (paid each semester)	5.00
Locker fee (paid each semester)	1.00
Graduation fee	6.00
Thesis fee	5.00

LABORATORY FEES.

Mining III and XVII (each)	$ 5.00
Mining IV	.50
Metallurgy II	20.00
Metallurgy X, XII, XVI, XVIII, XIX, and XX (each)	5.00

Metallurgy XIV	2.00
Metallurgy XXI	.50
Geology III	15.00
Geology VI, XIII and XIV (each)	3.00
Geology VII and IX (each)	5.00
Civil Engineering I and IV (each)	5.00
Civil Engineering VI	2.00
Civil Engineering VII and VIII (each)	.50
Mechanical Engineering II, IV, VI, VIII, X, XII, XV, and XIX (each)	.50
Mechanical Engineering XVIII	5.00
Electrical Engineering II, IV, and VI (each)	5.00
Chemistry VI	20.00
Chemistry V, XI, XII, XIV, XVIII, XXII, XXX, XXXII, and XXXIV (each)	10.00
Chemistry XIX, XX, XXIV, XXV, XXVI, and XXXIII (each)	5.00
Physics II, IV, and VI (each)	5.00

TEXT-BOOKS AND STUDENTS' SUPPLIES.

The cost of text-books and students' supplies necessarily vary, but the following are fair estimates:

Freshman year:	Text-books	$20.00
	Drawing supplies	20.00
Sophomore year:	Text-books	20.00
Junior year:	Text-books	25.00
Senior year:	Text-books	30.00

BOARD AND LODGING.

The college has no dormitory. Board can be obtained in private families for five to six dollars a week. Students' clubs furnish board for about twenty dollars a month. Rooms can be obtained for eight dollars to twelve dollars a month.

OTHER EXPENSES.

There are other expenses incidental to the mining, metallurgical, engineering, chemical, and geological trips, which vary so widely that they cannot be estimated. The preparation of the senior thesis may also involve expenses which vary with the nature and treatment of the subject.

Students leaving in mid-term, except on account of severe or protracted sickness, are not entitled to the return of fees or tuition. **All charges of the college are payable strictly in advance at the beginning of each semester.** No student is allowed to be graduated while indebted to the school. The Trustees reserve the right to make incidental changes in fees and deposits without printed notice, as new and unforeseen emergencies may arise.

Students who desire to earn money to defray their college expenses are advised to limit their work to the summer vacation.

The course of study is too exacting to allow much time during the college year for outside work.

The total expenses of the college year, including room and board but exclusive of tuition and the expenses of the senior trip, need not exceed five hundred dollars, and may, by strict economy, be considerably reduced.

SUMMER SCHOOL.

For the benefit of matriculated students who desire to make up deficiencies, or to work ahead of their classes, and for the benefit of prospective students, a Summer School has been established. It begins about the middle of July and continues for six weeks. Special circulars describing the courses offered will be sent, on application to the President.

ENGINEER COMPANY

National Guard of Colorado.

A company of engineers of the National Guard of Colorado is stationed in Golden. The officers of the company are:

Joseph C. Taylor.....Captain
Rastus S. Ransom, Jr.....First Lieutenant
Herbert T. Quick.....Second Lieutenant

On account of the value of the technical training received, the school allows a half hour credit for each full year of enlistment.

THE QUARTERLY.

Four times a year, in January, April, July, and October, the School issues the Quarterly. The various numbers include the Catalog, the Book of Views, Commencement addresses, and articles of a mining or of a metallurgical nature.

METHOD OF GRADING.

The following system of grading is used:

A—Excellent.
B—Good.
C—Fair.
D—Conditioned.
E—Failed or Subject Dropped.

A, B, and C are passing grades.

D (Conditioned) means that the student is not passed. The deficiency may be removed by passing a re-examination or by otherwise completing the work. Unless a condition is removed before the beginning of the next school year the D becomes an E.

E (Failed or Subject Dropped) means that the subject must be taken again, and that no subject depending upon this one may be taken until the E is removed. In removing an E the student must take the subject again either at a regular period

or under conditions approved in writing and in advance by the head of the department.

A student who at any time has conditions amounting to a total of twelve hours of work may not remove any of these conditions by re-examination, but must in each case take the subject again. In deciding whether a student has a total of twelve hours of conditions all Ds and Es received during the current school year will be counted; that is, in the first semester only first semester conditions will be counted, but in the second semester there will be added to the conditions received during that semester all unremoved conditions received during the first semester.

Three hours of laboratory or of drawing are regarded as the equivalent of one hour.

In case a student fails to complete his work in any subject the instructor may, at his discretion, report to the office not a D but an "Incomplete", which shall be designated by the letters "Inc." This is not regarded as a condition, but it becomes an E at the beginning of the next school year unless previously removed, or unless an extension of time is given in writing by the instructor in charge.

In case a student leaves school with one or more conditions and returns after an absence of a year or more, the term "next school year" will be interpreted to mean the next school year of his attendance; but in case he leaves at the close of the first semester he may return at a similar period a year or more later, subject to the conditions under which he left, as though there had been no break in his attendance, except in case of a changed curriculum.

No student may take any junior subject until he has received credit in all freshman subjects; and no student may take any senior subject until he has received credit in all freshman and sophomore subjects. In the case of students admitted to advanced standing, this rule is suspended during the first year of their attendance.

THE LIBRARY.

The college library occupies one-half of the second floor of Guggenheim Hall. The room is well lighted and ventilated and has a seating capacity for one hundred twenty readers. The library contains about twelve thousand volumes and several hundred pamphlets, principally of a technical nature, and is being increased in subjects corresponding to instruction given in the college. Direct access to the shelves is permitted to all students in order that they may secure the benefit of examining the books themselves. Books which are not needed for special reference work are loaned for home use for a period of two weeks. The card catalogue includes entries under author,

title, and subject, arranged on the dictionary plan. The classification is an adaptation of the Dewey decimal system to the needs of a technical library. Class 669 (Metallurgy) was expanded by R. M. Keeney '10 and published as a number of the Quarterly, and class 622 (Mining Engineering) was rearranged and expanded in a like manner by Professor Carl A. Allen '05, Assistant Professor of Mining. This was also published as a number of the Quarterly.

The library subscribes to the publications of the leading scientific societies of the world and to the chief literary and scientific periodicals. It is especially rich in files of engineering journals, the material in which is available for ready reference through excellent periodical indexes received monthly. The library is a depository for the documents of the United States Geological Survey and has an unusually complete collection of the publications issued by state geological surveys and mining bureaus both in this country and abroad. A collection of mine reports has recently been indexed and made available for reference.

During the academic year the library is open from 8 to 12 A. M., from 1 to 5, and from 7 to 9:30 P. M.,.except on Saturdays and holidays. On Saturdays the library is closed in the afternoon.

Y. M. C. A.

The College Young Men's Christian Association is one of the 776 that are now organized in the colleges and universities of the United States and Canada. More than 65,000 college men are members of the organization. The Y. M. C. A. of the Colorado School of Mines was organized in 1900 and has had a general secretary since 1906. The membership has reached half of the student body and includes the leaders in scholarship, athletics, and fraternity life. The Association exists for the purpose of helping the men of the school in every possible way. At the beginning of the school year the new men are assisted in securing rooms and boarding places An employment bureau is conducted throughout the year. The "Mines Hand Book" is published annually and distributed without charge to the students, alumni, and prospective students. It gives a detailed account of the various activities of the Association which include Bible Study, Mission Study, Religious Meetings, Social affairs, and a course of five popular entertainments. A copy of this book will be sent, upon application to the general secretary.

An advisory board, consisting of two Faculty members, one alumnus, one minister, and one business man, supervises the work of the Association. The present board members are: Professor Horace B. Patton, Professor Charles R. Burger, Rev. George E. Keithley, George W. Parfet, and Clare L Colburn.

The officers for 1912-13 are: President, J. B. Johnson, '14; Vice-President, Frank B. Harris, '13; Secretary, Charles E. Wuensch, '14; Treasurer, William L. Beck, '14; General Secretary, James C. Stephens, University of Wisconsin, '11.

THE INTEGRAL CLUB.

The Club Room is in the gymnasium building and is furnished in the ordinary style of a gentleman's club. The purpose of the club is to foster good comradeship among the students. It is under the direct control and management of a student committee:

Harry M. Cronin, '13, Chairman.
Neil M. McNeill, '14.
Alpheus B. Beall, Jr., '15.

PRIZES.

At the commencement exercises, May 24, 1912, the following prizes were awarded:

The Brunton Transit, presented by David W. Brunton, of Denver, to

Hugh Aloysius Stewart, and
Donald Llewellyn Beck.

Thesis: The geology and topography of Mount Bross and Buckskin Gulch, Mosquito Range, Colorado.

The Edward G. Stoiber Prize of one hundred fifty dollars to Alan Kissock.

Thesis: Aluminum and its reduction from the silicate.

SCIENTIFIC SOCIETY.

The scientific society has for its object the presentation and discussion of technical and engineering subjects. From time to time, lectures are delivered before the society by leading authorities on various topics of interest to its members and friends. The selection of these speakers is placed in the hands of an executive committee chosen from the senior and junior classes. All lectures are held in Simon Guggenheim Hall, on such nights as are most convenient for the majority of the students. The proceedings of the society are printed in "The Colorado School of Mines Magazine." The alumni, Faculty, senior, and junior classes of the institution constitute the active members of the organization; the sophomores and freshman are associates.

The officers for the year 1912-13 are:
Charles E. Prior, Jr., '13, President.
Frederick S. McNicholas, '14, Vice-President.
Herbert R. Hammond, '13, Secretary.
Meritt Hutton, '14, Treasurer.
Executive Committee: Peter A. Young, '13; Albert W. Smith,

'14; C. Arthur Swanson, '13; Burwell N. Kilbourn, '13; Robert R. Harper, '14; Elmer R. Wilfley, '14.

SOCIAL LIFE.

Social life in the college is fostered by a committee of students which consists of three members from each of the three upper classes. A reception is given about once a month. The committee for 1912-13 is:

Frank A. Downes, '13; Alfred Flinn, '13; C. J. Daman, '13; Eugene G. Snedaker, '14; Gilmore S. Davis, '14; James W. Pearce, '14; William S. Stringham, '15; Glenn H. Van Dorp, '15; Gilbert N. Rhoads, '15.

ATHLETIC ASSOCIATION.

By virtue of the athletic fee required, all students entering the School of Mines become members of the athletic association. The association is supported by the students' fees, by gate receipts, and by contributions from the alumni, and from other friends of the college. The treasurer of the school, Harry M. Rubey, Woods-Rubey National Bank, selected by the Board of Trustees, is ex-officio treasurer of the association. The affairs of the association are managed by a board of control, which consists of seven members; three undergraduates elected by the students, an alumnus selected by the alumni association, and three members of the Faculty elected by the Faculty.

The Board of Athletic Control for 1912-13 comprises:

Professor George W. Schneider, President.

Professor Ransom S. Hawley.

Assistant Professor John C. Bailar.

Arthur Hodgson, '99.

John R. Davis, '13, Secretary.

T. H. M. Crampton, '14.

Benjamin C. Essig, '15.

The athletic association maintains an office in the Gymnasium under the supervision of the athletic director, W. E. Johnston.

ALUMNI ASSOCIATION.

The aim of the alumni association is to promote acquaintance and friendship among the graduates, to encourage them to aid each other, and to make an organized effort to elevate and uphold the reputation and standard of their Alma Mater. To carry out these ideas, the association, under the management of an Assistant Secretary and Treasurer, publishes monthly the Colorado School of Mines Magazine and conducts an employment bureau, or capability exchange, for the benefit of the members.

All graduates are earnestly requested to join the association

and to keep the Assistant Secretary and Treasurer advised of their addresses and occupations.

The officers of the association are:

Arthur F. Hewitt, '05, President.

Charles H. McMahan, '92, Vice-President.

Edwin H. Platt, '00, Secretary.

William C. J. Rambo, '09, Treasurer.

Executive Committee—Junius W. Johnson, '01; Frederick S. Titsworth, '95; George W. Schneider, '94.

Orville Harrington, '98, Assistant Secretary and Treasurer; Editor and Manager of the Colorado School of Mines Magazine; Manager of the Capability Exchange.

The association holds its annual meeting and banquet on the day following the commencement exercises, unless otherwise provided for by the executive committee. All graduates are eligible to membership and are invited to the annual meeting and to the banquet.

A regular monthly luncheon is held in Denver on the third Saturday of each month at 12:30. All graduates of the school and the members of the junior and senior classes are invited to attend these informal luncheons, which are held to promote acquaintance and fellowship among Mines men. Members are privileged to bring guests.

ENROLMENT OF STUDENTS.

POSTGRADUATES.

Barney, Harry A.....Dayton, Ohio
C. E. Ohio Northern University.

Bisland, John B.....Houma, La
B. S. Louisiana State University.

Field, Edmund M.....Golden, Colo.
E. M. Colorado School of Mines.

Graham, Allan H.....Ottawa, Ohio
B. S. Ohio Wesleyan University.

Hayden, Wallace H.....Batavia, N. Y.
A. B. Bowdoin College.

Hudson, Waller C.....Lancaster, Ky.
A. B. Central University of Kentucky.
A. M. Princeton University.

Moses, P. S.....Savannah, Ga.
Ph. B. Sheffield Scientific School.
Yale University.

Westervelt, Edmund W.....Rochester, N. Y.
A. B. University of Rochester.

CLASS OF 1913.

SENIOR CLASS.

President, Frank A. Downes.
Vice-President, John F. Myers.
Secretary, Charles E. Prior, Jr.
Treasurer, C. Arthur Swanson.

Ailinger, Walter J.....Denver, Colo.
Arfsten, George J.....Denver, Colo.
Arthur, Charles S.....Denver, Colo.
Ball, Byron E.....Birmingham, Ala.
Georgia School of Technology.
Northwestern University.
Benner, Howard C.....Cleveland, Ohio
Bigley, Arthur C.....Golden, Colo.
Bronstein, Charles N.....Denver, Colo.
Cain, Louis S.....Denver, Colo.
Chapman, Irving A.....Brooklyn, N. Y.
Copeland, Clarence E.....Los Angeles, Calif.
Cowperthwaite, Edward W.....Coal Creek, Colo.
Cronin, Harry M.....Denver, Colo.
Daman, C. J.....Napoleon, Ohio
Ohio Northern University.
Dauth, Herman.....Denver, Colo.
Davis, John R.....Denver, Colo.
Dove, Dean R.....Denver, Colo.
Downes, Frank A.....Golden, Colo.
Dudgeon, James W.....Denver, Colo.
Eaton, Walter J.....Santa Ana, Calif.
Fay, Charles H.....Wyoming, Ohio
Fay, Herbert M.....Blue Hill, Neb.
Colorado College.
Flinn, Alfred.....Duluth, Minn.
Forbes, Henry H.....Westboro, Mass.
Cornell University.
Frankel, Jacob M.....New York, N. Y.
French, Clare L.....Rifle, Colo.
Colorado Agricultural College.
Frey, Carl E.....Grand Junction, Colo.
Gregg, Daniel B.....Cincinnati, Ohio
University of Cincinnati.
Hammond, Herbert R., Jr.....Denver, Colo.
Harris, Frank B.....Fruita, Colo.
Heinrichs, Walter E.....Pittsburgh, Pa.
Ho, Cheih.....Canton, China
Tangshan Engineering and Mining College, China.

Hugo, Herman W.....Indianapolis, Ind.
Kilbourn, Burwell N.....Pueblo, Colo.
Klatt, Carl L.....Golden, Colo.
Leahy, Richard A.....Southsea, Hampshire, England
Throop Polytechnic Institute.
Light, Victor A.....Golden, Colo.
Martinez, Fidel.....Monterey, N. L., Mexico
Rensselaer Polytechnic Institute.
Mathews, Harvey.....Pueblo, Colo.
McGregor, M. G. S.....Maywood, Ill.
Myers, John F.....Columbus, Ohio
Neiswender, Chester B.....Los Angeles, Cal.
University of Southern California.
Nieman, Earl F.....Chicago, Ill.
Nolan, Philip E.....Green Bay, Wis.
Ripon College.
Oram, Charles F.....Golden, Colo.
Peregrine, William D.....Golden, Colo.
Place, J. Sterling.....Orange, N. J.
Pennsylvania State College.
Price, Harold C.....New York, N. Y.
Prior, Charles E., Jr.....New York, N. Y.
Ransom, Rastus S., Jr.....New York, N. Y.
Columbia University.
Rusman, Benjamin A.....Denver, Colo.
Smith, Howard C.....Cripple Creek, Colo.
Solomon, Irwin R.....St. Louis, Mo.
University of Colorado.
Colorado College.
Stein, Edmund.....Golden, Colo.
Stephens, Frank M.....Denver, Colo.
University of Denver.
Stronck, Herbert N.....Le Mars, Iowa
Swanson, C. Arthur.....Golden, Colo.
Trueheart, Lawrence G.....San Antonio, Texas
Wang, S. Y.....Canton, China
Tangshan Engineering and Mining College, China.
Ward, Merwin H.....Everett, Mass.
Massachusetts Institute of Technology.
Warren, Seymour P.....San Diego, Calif.
Watson, Samuel E.....Clarksville, Texas
Wigton, George H.....Denver, Colo.
Wilfley, George.....Denver, Colo.
Wilkinson, Mearle W.....Denver, Colo.
Williams, John C.....Golden, Colo.
Wong, William A.....Honolulu, Hawaii
Colorado College.
Boone University, Wu Chang, China.
Wright, Thomas W.....Golden, Colo.
Young, Peter A.....Denver, Colo.

CLASS OF 1914.

JUNIOR CLASS

President, Eugene G. Snedaker.
Vice-President, Philip J. McGuire.
Secretary, James W. Pearce.
Treasurer, Frank L. Pittman.

Baker, Erwin F.....Denver, Colo.
Beck, W. Lloyd.....Denver, Colo.
Billyard, J. R. H. H.....Valparaiso, Chile, S. A.
Brandow, Glenn A.....Canandaigua, N. Y.
Bregman, Adolph.....Victor, Colo.
Brooke, Lionel.....Los Angeles, Calif.
Brousseau, Andre R.....New Orleans, La.
Brugger, Melvin.....Columbus, Neb.
Cadot, John J.....Chicago, Ill.
Callahan, Thomas W.....Golden, Colo.
Carper, Armistead F.....Denver, Colo.
University of Wisconsin.
Chen, Yefah.....Shanghai, China
St. John's University, Shanghai, China.
Cheng, Dah-Chun.....Kiang-yin, China
Fu-Tan College, China.
Clark, Louis F.....Grand Rapids, Mich.
Clarke, Roscoe H.....Oklahoma City, Okla.
University of Oklahoma.
Craig, Allan E.....Denver, Colo.
Crampton, T. H. M.....Golden, Colo.
Davis, Gilmore S.....Trinidad, Colo.
Espinosa, Miguel E.....Mexico City, Mex.
University of Illinois.
Fischer, Oscar A.....Chicago, Ill
University of Illinois.
Foo, Shu.....Chungking, China
Fu-Tan College, China.
Gow, Thomas T.....Tunchow, Shantung, China
Shantung Union College, China.
Grant, Bertram.....Philadelphia, Pa.
Graybeal, Edward V.....De Beque, Colo.
Grigsby, Gail G.....Denver, Colo.
Griswold, George G., Jr.....Golden, Colo.
Hammen, Charles W.....Chicago, Ill.
Harper, Robert R.....Des Moines, Iowa
Hutton, Meritt.....Denver, Colo.

Johnson, John B.....Wheeling, W. Va.
Washington and Jefferson College.
Koelker, Karl L.....Toledo, Ohio
Purdue University.
Krohn, Arthur.....Chicago, Ill.
Krumm, Samuel Z.....Columbus, Ohio
Ohio State University.
Lee, Ping.....Wusih, China
Imperial College of Peking, China.
Litchfield, Rufus E.....Fitchburg, Mass.
Luke, Russell B.....Wilkesbarre, Pa.
McGuire, Philip J.....Denver, Colo.
McNeill, Neil M.....Plum Bush, Colo.
McNicholas, Frederick S.....Durango, Colo.
Pearce, James W.....Denver, Colo.
University of Colorado.
Pittman, Frank L.....Tacoma, Wash.
Roberts, Keith.....Chicago, Ill.
Sallen, Edward W.....Denver, Colo.
Shurtleff, Ernest S.....Boston, Mass.
Massachusetts Institute of Technology.
Smith, Albert W.....Pueblo, Colo.
Smith, Ralph W.....Denver, Colo.
Snedaker, Eugene G.....Denver, Colo.
Tsui, Y. L.....Wu-Chang, China
Imperial Polytechnic College, Shanghai, China.
Turner, John H.....Golden, Colo.
Van Dolah, Parks B.....Victor, Colo.
Colorado Agricultural College.
Wallace, Frederick H.....Hungary
Armour Institute of Technology.
Royal University, Klausenburg, Hungary.
Watrous, Mark U.....Monte Vista, Colo.
Weller, Simon T.....Denver, Colo.
Whitaker, Charles N., Jr.....Denver, Colo.
Wilfley, Elmer R.....Denver, Colo.
Woolf, Joe H., Jr.....Greeley, Colo.
Wuensch, Charles E.....Newark, N. J.
Yang, W. T.....Cheng-tu, China
Fu-Tan College, China.
Zulch, William G.....Denver, Colo.

CLASS OF 1915.

SOPHOMORE CLASS.

President, William F. Stringham.
Vice-President, Alfred F. Duggleby.
Secretary, Rex P. Oliveros.
Treasurer, Charles H. Baker.

Anderson, Raymond B.....New York, N. Y.
Baker, Charles H.....Washington, Pa.
Bayly, Taver.....Atlanta, Ga.
Beall, Alpheus B., Jr.....Sioux City, Iowa
Beam, John W.....Denver, Colo.
Bebee, Alfred H.....Cripple Creek, Colo.
Berthier, Ulysses H.....Mexico City, Mexico
Spring Hill College.
Boehmer, Max, Jr.....Denver, Colo.
Amherst College.
Bolam, Albert E.....Reno, Nev.
Burns, Jay.....Franklin, Pa.
Burris, Samuel J., Jr.....Pueblo, Colo.
Butner, Daniel W.....Colorado Springs, Colo.
Carlson, Monroe E.....Denver, Colo.
University of Denver.
Chang, Kingfan.....Swatow, China
Cing Hua College, Peking, China.
De Laittre, Horace H.....Minneapolis, Minn.
Dodge, David C., Jr.....Denver, Colo.
Dowden, Ethelbert, Jr.....Plainview, Texas
Duggleby, Alfred F.....Davenport, Iowa
Essig, Benjamin C.....Owosso, Mich.
Michigan Agricultural College.
Franklin, Wells A.....Rochester, N. Y.
Goldfain, George.....Denver, Colo.
Grauting, Hugo G.....Florence, Colo.
Greenwood, John H.....Salt Lake City, Utah
Gregory, Arthur E.....Savannah, Ga.
Alabama Polytechnic Institute.
Haselton, Charles F.....Chicago, Ill.
Heatley, Francis E.....Denver, Colo.
Higgins, Reuben, Jr.....South Portland, Me.
Tufts College.
Hinman, Dale D.....Austin, Colo.
Hutchison, William E.....Denver, Colo.
Iowa State College.
Kaanta, Henry.....Golden, Colo.

Krieger, Adam C.....Pueblo. Colo.
University of Oregon.
Lee, Arthur L.....Johnstown, Colo.
Leet, Benjamin.....Kaslo, B. C.
Spokane College.
Long, Ye.....Yuin Shien, China
Cing Hua College, Peking, China.
McKnight, Hugh S.....Dallas, Texas
University of the South.
Merry, Frank P.....Cleveland, Ohio
Baltimore Polytechnic Institute.
Oliveros, Rex P.....Savannah, Ga.
Alabama Polytechnic Institute.
Olson, Van Cleave A.....Alexandria, Minn.
Ord, James.....Chevy Chase, Md.
Page, Walter C.....Grand Junction, Colo.
University of Colorado.
Rhoads, Gilbert N.....Roswell, N. M.
Rogers, Charles A.....Salida, Colo.
Rosette, Breese.....De Kalb, Ill.
Samuelson, A. C.....Salt Lake City, Utah
University of Utah.
Sanchez, John T.....Laredo, Texas
University of Texas.
Schneider, George L.....Golden, Colo.
Shanley, John R., Jr.....Denver, Colo.
Simon, William W.....Florence, Colo.
Leland Stanford Jr. University.
Stewart, L. Adair.....Ouray, Colo.
University of Kansas.
Stringham, William S.....Denver, Colo.
Swigart, Mervyn S.....Carbondale, Colo.
Teets, John N.....Red Cliff, Colo.
Todd, Clarence T.....Stockton, N. Y.
Tsai, Hsiang.....Hangkow, China
Boone University, Wu Chang, China,
Van Dorp, Glenn H.....Topeka, Kas.
Walter, Adolph S.....Denver, Colo.
University of Virginia.
Wang, Chinting M.....Foochow, China
Anglo-Chinese College, Foochow, China.
Whetsel, Raymond V.....Fortville, Ind
Purdue University.
White, Leonard L.....Golden, Colo.
Wood, Fletcher H.....Mt. Vernon, N. Y
Sheffield Scientific School, Yale University.
Worcester, Arthur W.....Cripple Creek, Colo
Valparaiso University.

CLASS OF 1916.

FRESHMAN CLASS.

President, Frank E. Briber.
Vice-President, Douglas H. Platt.
Secretary, Burton A. Laylin.
Treasurer, Alvah L. Miller.

Aros, Juan.....San Francisco, Calif.
University of Madrid.
Blaurock, Carl A.....Denver, Colo.
Breene, Francis H.....Denver, Colo.
Brenneman, Frederick G.....Eureka, Colo.
Brenneman, John F.....Eureka, Colo.
Briber, Frank E.....Denver, Colo.
Cashmore, Clair.....Denver, Colo.
Chatin, August.....Walsenburg, Colo
Christian, George L.....Leadville, Colo.
Ferguson, Kenneth S.....Denver, Colo.
Fleming, Charles W.....Silverton, Colo.
Follansbee, Frank S.....Fort Spring, W. Va.
Emory and Henry College.
Fullaway, R. Merle.....Los Angeles, Cal.
Garrison, Murray E.....Golden, Colo.
Gauthier, Charles B.....Detroit, Mich.
Geib, Francis H.....Denver, Colo.
Glerum, Louis A.....Devils Lake, N. D.
Grimes, Maxwell.....Denver, Colo.
Hammen, Edwin A.....Chicago, Ill.
Harrod, Wayne A.....Fort Wayne, Ind.
Heller, Alfonce H.....Santa Maria, Calif.
Hornickel, Howard E.....Cleveland, Ohio
Lavender, Harry M.....Telluride, Colo.
Laylin, Burton A.....Denver, Colo.
Lea, Hunyet.....Passar Barse, Batavia, Java
Levy, Milton M.....Denver, Colo.
Lliteras, Juan M.....Hermosillo, Sonora, Mexico
Miller, Alvah L.....Brooklyn, N. Y.
Mould, Willis P.....Morrisville, Vt.
University of Vermont.
O'Callahan, Francis T.....Pittsburgh, Pa.
Pfeiffer, Cyril J.....Golden, Colo.
Platt, Douglas H.....Leadville, Colo.
Ryan, Edward E.....Fall River, Mass.
Sapp, William M.....Galena, Kas.
Setz, Helmuth G.....San Antonio, Texas

Smith, Frank A.....San Pedro, Calif.
Throop Polytechnic Institute.
Stampfel, Frank J.....Rico, Colo.
Steele, Oliver W.....Dallas, Texas
Stryker, Roy E.....Montrose, Colo.
Sutliff, Howard D.....National City, Calif.
Tamayo, Fernando C.....San Cristobal, Venezuela
Traver, William M., Jr.....Central City, Neb.
Urteaga, Santiago.....Candela, Coahuila, Mexico
Van Burgh, Lisle.....Denver, Colo.
Wade, Richard E., Jr.....Oklahoma City, Okla.
Whalen, John M.....Des Moines, Iowa
White, Harold M.....Buffalo, Mont.
Wiebelt, Frank J.....Arvada, Colo.
Wilson, Edgar, Jr.....Boise, Idaho
Whitman College.
Winchell, John H., Jr.....Edgewater, Colo.

SUMMARY.

Postgraduates	8
Seniors	68
Juniors	59
Sophomores	61
Freshmen	49
Total	245

INDEX.

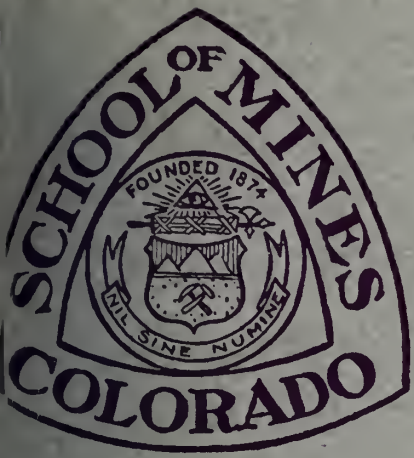
Page
Admission Requirements 35
Advanced Engineering Drawing, Course in..... 88
Advanced General Metallurgy, Course in..... 73
Advanced Geology, Course in..... 78
Advanced Industrial Chemistry, Course in.....103
Advanced Metallography, Course in..... 73
Advanced Projection, Course in..... 87
Advanced Standing, Admission to..... 38
Algebra, Course in.....110
Alternating Current Machinery, Courses in.....95, 96
Alumni Association.....130
Analytic Geometry, Course in.....111
Antimony, Course in the Metallurgy of..... 66
Applied Electricity, Courses in..... 97
Assay Laboratory 28
Assaying, Courses in..... 64
Astronomy, Course in.....113
Athletic Association 130
Bismuth. Course in the Metallurgy of..... 67
Board, Cost of.....125
Board of Trustees..... 11
Books, Cost of.....125
Buildings 20
Cadmium, Course in the Metallurgy of..... 67
Calculus, Courses in.....112
Calendar 9
Carpenter Shop 22
Ceramic Geology, Course in..... 81
Chemical Laboratories 29
Chemistry, Courses in.....98-107
Civil Engineering, Courses in.....83-86
Coal and Gas Analysis, Course in.....103
Coal Mining Equipment, Course in..... 60
Coal Testing, Course in..... 94
Collections, Geological and Mineralogical..... 26
College Algebra, Course in.....110
Commercial Ores, Collection of..... 26
Compressed Air, Course in..... 90
Conditions 126
Copper, Course in the Metallurgy of..... 69
Crystallography, Course in..... 76
Degrees 38
Departments of Instruction—
Mining 54-63
Metallurgy 64-74
Geology and Mineralogy.....75-82
Civil Engineering 83-86
Mechanical Engineering 87-94
Electrical Engineering 95-97
Chemistry 98-107
Physics 108, 109
Mathematics 110-113

Page
English 114
Mining Law 115
Deposits 124
Descriptive Geometry, Course in.... 87
Diplomas 39
Direct Current Machinery, Courses in.... 95
Drawing Rooms 34
Economic Geology, Course in.... 79
Economics of Coal Mining, Course in.... 61
Economics of Metal Mining, Course in.... 61
Electrical Laboratory 31
Electrical Plant Trips 122
Electricity, Special Apparatus and Appliances, Courses in.. 96
Electrometallurgy, Courses in....70, 71
Electrometallurgical Laboratory 31
Electrical Engineering, Courses in.... 95
Electrochemical Analysis, Course in....104
Engineer Company, N. G. C....126
Engineering Construction, Course in.... 85
Engineering Drawing, Couse in.... 87
English, Courses in....114
Enrolment of Students....132
Entrance Examinations 36
Entrance Requirements 35
Equipment 23
Exchanges, Geological and Mineralogical.... 26
Experimental Ore Dressing and Metallurgical Plant.....21-23
Expenses—
Tuition 124
Fees and Deposits....124
Board and Lodging....125
Books and Students' Supplies....125
Other Expenses 125
Faculty 12
Failures 126
Fees 124
Fellows 13
Field Geology, Courses in.... 78
Financial Support 17
First Aid and Rescue Work, Course in.... 63
Gas Analysis, Course in....103
Gems and Gem Mining, Course in.... 80
General Chemistry, Courses in.... 98
General Geology, Courses in....75, 76
General Information 124
General Physics, Courses in....108, 109
Geodesy, Course in....113
Geological Exchanges 26
Geological Laboratory and Cabinet.... 26
Geological and Topographical Maps, Course in.... 81
Geology, Courses in....75-82
Geology of the Non-Metals, Course in.... 81
Geometry, Analytic, Course in....111
Geometry, Descriptive, Courses in.... 87
Gold, Course in the Metallurgy of.... 68
Grading, Method of....126
Graduation 39
Gymnasium 20
Hall of Chemistry 20
Hall of Physics 21
Heating, Lighting, and Power Plant.... 21
History of the College.... 17

Page
Hydraulic Laboratory 29
Hydraulics, Courses in..... 85
Industrial Chemistry, Courses in.....100
Industrial Chemistry Trips 122
Industrial Inorganic Chemistry, Course in.....106
Industrial Organic Chemistry, Course in.....106
Inspection Trips 116
Integral Club 129
Internal Combustion Engines, Course in..... 92
Iron, Course in the Metallurgy of..... 65
Laboratories and Equipment..... 23
Lead, Course in the Metallurgy of..... 66
Lecturers, Special 14
Library 127
Lithology, Course in..... 78
Location, Advantage of..... 18
Lodging, Cost of.....125
Machine Design, Courses in.....88, 89
Machine Shop 22
Magazine, The Alumni.....130
Mathematics, Courses in.....110-113
Mechanical Engineering, Course in..... 93
Mechanical Engineering Laboratory 33
Mechanical Power Plant Trip.....122
Mechanics of Engineering, Courses in.....83, 84
Mechanics of Engineering Laboratory..... 31
Mercury, Course in the Metallurgy of..... 68
Metallography, Courses in.....68, 69
Metallurgical Administration, Course in..... 68
Metallurgical Chemistry, Courses in.....102
Metallurgical Collections 27
Metallurgical Laboratory 27
Metallurgical Laboratory, Courses in.....68, 69
Metallurgical Plant Design, Course in..... 74
Metallurgical Practice, Courses in..... 72
Metallurgical Seminar 68
Metallurgical Trips 123
Metallurgy, Courses in.....64-74
Methods of Coal Mining, Course in..... 59
Methods of Metal Mining, Courses in.....56, 57
Microscopic Petrography, Course in..... 79
Mineral Land Surveying, Course in..... 54
Mineralogical Exchanges 26
Mineralogical Laboratory and Cabinet.....26, 27
Mineralogy, Course in..... 76
Mine Accounting, Courses in..... 62
Mine Examinations and Reports, Course in..... 60
Mine Management, Course in..... 63
Mine Mapping, Course in..... 55
Mine and Mill Plant Design, Course in..... 93
Mine Plant Testing, Course in..... 94
Mine Surveying, Courses in..... 54
Mining, Courses in.....54-63
Mining Geology, Course in..... 80
Mining Laboratory 32
Mining Laboratory, Course in..... 61
Mining Law, Course in.....115
Mining Trips 121
Museum, Geological and Mineralogical..... 26
Museum of Applied Chemistry..... 29
Nickel, Course in the Metallurgy of..... 68
Ore Deposits, Course in..... 79

Page
Ore Dressing, Course in..... 67
Ores, Collection of..... 26
Organic Chemistry, Courses in.....105
Organization 17
Petrography, Course in..... 79
Physical Chemistry, Course in.....103
Physical Laboratories 30
Physics, Courses in.....108, 109
Plane Surveying, Course in..... 83
Postgraduate Students 38
Power Plant 21
Power Plant Design, Courses in..... 91
Precise Surveying and Geodesy, Course in.....113
President, Office of 20
President, Residence of 22
Practices of Coal Mining, Course in the..... 59
Practices of Metal Mining, Courses in the.....57, 58
Principles of Coal Mining, Course in the..... 58
Principles of Metal Mining, Course in the..... 56
Prizes 129
Pumping Machinery, Course in..... 92
Qualitative Analysis, Courses in.....99, 100
Quantitative Analysis, Courses in.....100, 101, 102
Quarterly, The 126
Radioactivity and Spectroscopy, Course in.....109
Rare Metals, Courses in.....103
Rare Metals Laboratory..... 33
Registrar, Office of..... 20
Requirements for Admission to the Freshman Class..... 35
Requirements for Admission to Advanced Standing..... 38
Rescue Work, Course in..... 63
Research Work 25
Scientific Society 129
Senior Trip 116
Silver, Course in the Metallurgy of..... 68
Simon Guggenheim Hall.....
Social Life 130
Special Lecturers 14
Steam Engines and Boilers, Courses in.....89, 90
Steel, Course in the Metallurgy of..... 65
Stoichiometry, Courses in.....104
Stratton Hall 21
Structural Details, Course in..... 86
Students, Enrolment of.....132
Summer School 126
Support, Financial 17
Surveying, Courses in 54, 83
Surveying Equipment 28
Tabular Views 41-53
Technology of the Non-Metals, Course in.....107
Testing Laboratory for Mechanics of Engineering..... 31
Testing Plant 23
Text-Books, Cost of.....125
Theoretical Chemistry, Courses in.....106
Theses 39
Trigonometry, Course in.....111
Trustees, Board of..... 11
Tuition 124
Y. M. C. A.....128
Zinc, Course in the Metallurgy of..... 67

THE UNION PR



QUARTERLY

Vol. IX. No. 1.

1914-16

Entered as second-class mail matter July 10, 1906, at the Post Office at Golden, Colorado, under the Act of Congress of July 16, 1894

THE
JOHN CRERAR
LIBRARY

The Experimental Ore Dressing and Metallurgical Plant, Colorado School of Mines.

QUARTERLY

of the

COLORADO SCHOOL *of* MINES

Vol. IX. No. 1.
Catalogue Edition

GOLDEN, COLORADO
1914-1916

TABLE OF CONTENTS.

(For Complete Index, see Page 149.)

	Page
College Calendar	9
Board of Trustees	11
Faculty	12, 13
Special Lecturers	15, 16
Standing Committees of the Faculty	14
Location and Description, History, Organization, Financial Support	19-22
Buildings	23, 24, 25
Laboratories and Equipment	26-37
Requirements for Admission	38-43
Departments of Instruction—	
Tabular Views	46-51
Mining	52-59
Metallurgy	60-69
Geology and Mineralogy	70-75
Civil Engineering	76-80
Electrical Engineering	81-83
Mechanical Engineering	84-91
Chemistry	92-97
Physics	98-100
Mathematics	101-106
English	107
Modern Languages	108-110
Mining Law	111
Inspection Trips	112-123
General Information	124-133
Enrolment of Students	134-141
Alumni	142-148
Index	149

COLLEGE CALENDAR.

1914.

April 1, Wednesday	Short Course in Coal Mining begins.
May 22, Friday	Second Semester ends. Commencement Exercises.
May 25, Monday	Summer Work in Surveying begins.
May 27, Wednesday	Short Course in Coal Mining ends.
July 3, Friday	Summer Work in Surveying ends.
July 20, Monday	Summer School begins.
August 29, Saturday	Summer School ends.
September 2, Wednesday September 3, Thursday September 4, Friday	Examinations for Entrance to the Class of 1918 and Re-examination of Matriculated Students.
September 8, Tuesday	Opening of the First Semester of the Academic Year 1914-15.
November 26, Thursday November 27, Friday November 28, Saturday	Thanksgiving Recess.
December 21, Monday	Christmas Recess begins.

1915.

January 2, Saturday	Christmas Recess ends.
January 23, Saturday	First Semester ends.
January 25, Monday	Second Semester begins.
February 12, Friday	Lincoln's Birthday (A Holiday).
February 22, Monday	Washington's Birthday (A Holiday).
April 1, Thursday	Short Course in Coal Mining begins.
May 27, Thursday	Short Course in Coal Mining ends.

May 28, Friday	Second Semester ends. Commencement Exercises.
May 31, Monday	Summer Work in Surveying begins.
July 10, Saturday	Summer Work in Surveying ends.
July 19, Monday	Summer School begins.
August 28, Saturday	Summer School ends.
September 1, Wednesday September 2, Thursday September 3, Friday	Examinations for Entrance to the Class of 1919, and Re-examination of Matriculated Students.
September 7, Tuesday	Opening of the First Semester.
November 25, Thursday November 26, Friday November 27, Saturday	Thanksgiving Recess.
December 20, Monday	Christmas Recess begins.

1916.

January 1, Saturday	Christmas Recess ends.
January 22, Saturday	First Semester ends.
January 24, Monday	Second Semester begins.
February 12, Saturday	Lincoln's Birthday (A Holiday).
February 22, Tuesday	Washington's Birthday (A Holiday).

BOARD OF TRUSTEES.

FREDERICK C. STEINHAUER, E. M., Denver, Colo.
President.
Term expires, 1915.

JAMES T. SMITH, Denver, Colo.
Secretary.
Term expires, 1917.

WILLIAM J. BENNETT, Golden, Colo.
Term expires, 1915.

EDMOND C. VAN DIEST, E. M., Colorado Springs, Colo.
Term expires, 1915.

FRANK G. WILLIS, E. M., Cripple Creek, Colo.
Term expires, 1917.

HARRY M. RUBEY, Woods-Rubey National Bank, Golden, Colo.
Treasurer.

The regular meetings of the Board of Trustees are held in Golden at the School of Mines on the second Thursday of each month.

FACULTY.

WILLIAM GEORGE HALDANE, B. S.,
Acting President.

REGIS CHAUVENET, B. S., A. M., L. L. D.,
President Emeritus.
Special Lecturer in Metallurgy and Chemistry.

PAUL MEYER, Ph. D.,
Professor Emeritus of Mathematics.

HORACE BUSHNELL PATTON, Ph. D.,
Professor of Geology and Mineralogy.

HERMAN FLECK, Nat. Sc. D.,
Professor of Chemistry.

FRANK WEISS TRAPHAGEN, Ph. D., F. C. S.,
Professor of Metallurgy.

CHARLES ROLAND BURGER, A. B.,
Professor of Mathematics.

LOUALLEN FREDERICK MILLER, A. M.,
Professor of Physics.

WILLIAM JONATHAN HAZARD, E. E.,
Professor of Electrical Engineering.

RANSOM SMITH HAWLEY, B. S.,
Professor of Mechanical Engineering.

HARRY JOHN WOLF, E. M., M. S.,
Professor of Mining.

CHARLES DARWIN TEST, B. M., E. A. C.,
Assistant Professor of Chemistry.

JOHN CHRISTIAN BAILAR, A. M.,
Assistant Professor of Chemistry.

GEORGE EULAS FOSTER SHERWOOD, A. M.,
Assistant Professor of Mathematics.

HARRY MUNSON SHOWMAN, E. M.,
Assistant Professor of Civil Engineering.

WILLIAM REUEL CHEDSEY, E. M.,
Assistant Professor of Mining.

HYRUM SCHNEIDER, A. M.,
Instructor in Geology and Mineralogy.

CLAUDE SYLVESTER JOHNSON, B. S.,
Instructor in Mechanical Engineering.

ILO IVAN TAYLOR, B. S.,
Instructor in Mechanical Engineering.

RALPH ROY KNOWLES, B. S.,
Instructor in Physics and Electrical Engineering.

JENNER ALFRED PYNCH, A. B.,
Instructor in Geology and Mineralogy.

EDWARD JULIUS DITTUS, E. Met.,
Instructor in Metallurgy.

FREDERICK S. TITSWORTH, C. E., E. M., L. L. B.,
Lecturer in Mining Law.

ERLE OATMAN KISTLER, Ph. B.,
Director of Physical Training.

THOMAS COURTLAND DOOLITTLE,
Registrar.

PEARL GARRISON,
Librarian.

ALICE LYLE,
Secretary to the President.

ARTHUR L. RAE,
Engineer.

HENRY J. GUTH,
Pattern Maker.

STANDING COMMITTEES OF THE FACULTY.

Committee on Courses of Study.

PROFESSOR CHAUVENET, PROFESSOR PATTON,
PROFESSOR HAZARD, PROFESSOR CHEDSEY,
PROFESSOR TEST.

Committee on Admission to Advanced Standing.

PROFESSOR PATTON, PROFESSOR HAWLEY,
PROFESSOR SHERWOOD.

Committee on Student Activities.

PROFESSOR FLECK, MR. SCHNEIDER, MR. DITTUS.

Committee on Irregular and Conditioned Students.

PROFESSOR BURGER, PROFESSOR FLECK,
PROFESSOR SHOWMAN, PROFESSOR MILLER.

Committee on Absences.

Students' Advisory Committee,
PROFESSOR TRAPHAGEN, Chairman.

Committee on Catalogue.

PROFESSOR FLECK, PROFESSOR WOLF,
PROFESSOR SHERWOOD.

Committee on Library.

PROFESSOR FLECK, PROFESSOR WOLF,
MR. KNOWLES.

Students' Advisory Committee.

Freshmen ..... PROFESSOR BAILAR
Sophomores ..... PROFESSOR MILLER
Juniors ..... PROFESSOR PATTON
Seniors ..... PROFESSOR TRAPHAGEN

Rocky Mountain Athletic Conference.

Faculty Member ..... PROFESSOR PATTON

SPECIAL LECTURERS.

HON. EDWARD T. TAYLOR, Glenwood Springs, Colo.
The Panama Canal.

FRANK E. SHEPARD, Denver, Colo.
President, Denver Engineering Works Co.
The Development of Modern Mill Systems.
Recent Advances in Coarse Crushing.

WALTER G. SWART, Denver, Colo.
Manager, American Zinc Ore Separating Co.
Filing Systems.
Recent Developments in Dry Milling.
Modern Practice in Zinc Metallurgy.
Electrostatic Ore Separation.

THOMAS B. CROWE, Victor, Colo.
Superintendent, New Portland Mill.
The Metallurgy of Cripple Creek Ores.

GEORGE E. COLLINS, Denver, Colo.
Mining Engineer.
The Economics of Metal Mine Accidents.

LUCIEN I. BLAKE, Boston, Mass.
Consulting Engineer, Submarine Telegraph Co.
The New Theory of Energy.
Patents.

JOHN A. TRAYLOR, New York, N. Y.
President, Traylor Engineering Works Co.
Jigs.

L. S. PIERCE, Denver, Colo.
The Pierce Amalgamator.

W. H. TRASK, JR., Denver, Colo.
Central Colorado Power Co.
Hoisting.

GEORGE J. BANCROFT, Denver, Colo.
Mining Engineer.
Ore Deposition.

JOHN L. MALM, Denver, Colo.
Metallurgical Engineer.
The Future of Chemical Engineering.

JAMES M. McCLAVE, Denver, Colo.
Metallurgist.
The Garfield Tables.

MAX W. BALL, Washington, D. C.
United States Geological Survey.

The Organization and Work of the U. S. Geological Survey.

PHILIP M. McHUGH, Denver, Colo.
Dorr Cyanide Machinery Co.

Continuous Decantation.

M. J. SHIELDS, M. D., Washington, D. C.
American Red Cross Society.

First Aid to the Injured.

JOHN W. AMESSE, M. D., Denver, Colo.

Diseases of Warm Climates.

CHAUNCEY E. TENNANT, M. D., Denver, Colo.

First Aid to the Injured.

HOWARD C. PARMELEE, Denver, Colo.
Western Editor, Metallurgical and Chemical Engineering.

The Value of Inspection Trips.

PHILIP ARGALL, Denver, Colo.
Consulting Metallurgist.

The Flotation Process.

A. M. PLUMB, Denver, Colo.
American Zinc Ore Separating Co.

Dry Separation Processes.

WM. M. DAVIS, M. E., S. D., Ph. D., Harvard University.

Theories of Coral Reefs.

History of the Front Range, Colorado.

THE
JOHN CRERAR
LIBRARY

The Campus.

LOCATION AND DESCRIPTION, HISTORY, ORGANIZATION, AND FINANCIAL SUPPORT.

LOCATION AND DESCRIPTION.

The Colorado School of Mines is in the south central part of the City of Golden, Jefferson County, Colorado. It occupies a plat of approximately twenty-three acres, picturesquely situated about 200 feet above the bed of Clear Creek, at the base of the scenic front range which lies about fifty miles to the east of the main range of the Rocky Mountains. Farther east, about thirteen miles, lies the City of Denver, which can be reached by three railway lines: the Denver and Intermountain Railroad, Arapahoe Street Station; the Denver and Northwestern Railway, Fifteenth Street Loop or Union Depot; or the Colorado & Southern Railway, Union Depot.

Golden has about three thousand inhabitants, and is one of the oldest cities in Colorado. The altitude is five thousand seven hundred feet above sea level, or about four hundred fifty feet above Denver. The climate is invigorating and bracing, with open winters and a large proportion of clear days.

The Colorado School of Mines is particularly fortunate in its natural surroundings and proximity to a rich, practical laboratory. The State of Colorado is famous for its basic industries, the mining of gold, silver and the baser metals, all of which, together with their allied branches of industry, are highly developed within a relatively small area, every part of which is easily accessible from Golden. In addition, the vast vanadium, tungsten, uranium, and radium fields are better represented here than in any other part of the world. In view of its great number of mining and metallurgical enterprises and the variety thereof, the State offers unexcelled opportunities for practical study.

The school is fortunately situated for the geologist. The surrounding formations not only present the strikingly clear features so characteristic of the West, but also occur in great profusion and variety. In addition, certain features peculiar to this locality afford sufficiently complicated problems to be of great value to the student of geology. It is possible, therefore, without going more than a mile or two from the school to illustrate effectively most geological problems so that field geology can be carried on at the same time with class instruction.

In the immediate vicinity of Golden are numerous clay mines, which produce pottery clay and fire clay; also lime and stone quarries. Within a few miles are extensive coal mines well equipped with hoisting and power machinery; pyritic smelting works; and the sites of dredging and dry placer operations.

In Clear Creek Canon, a short distance west of Golden, are the historic mining camps of Central City, Black Hawk, Idaho Springs and Georgetown, where placer drift-mining is carried on in the old river beds, and a great variety of lode mines and milling plants are in operation. The ores of this district vary from free-milling gold quartz to complex silver-lead-zinc ores.

Farther west is the camp of Breckenridge, where placer mining is carried on, and the small mining camps of Montezuma, Kokomo, and Robinson. To the southwest is the famous Leadville district, well known for its rich lead and zinc ores. West of Leadville is the once renowned silver mining camp of Aspen, and to the north of Leadville are the lead-zinc camps of Redcliffe and Gilman.

At the Globe plant of the American Smelting and Refining Company in Denver, the treatment of lead ores and dry ores of gold and silver is illustrated. Here also the many mining and metallurgical machinery plants afford an excellent opportunity for the study of recent improvements in metallurgical design.

West of Colorado Springs are located the Portland, the Standard and the Golden Cycle Mills, which treat ore from the Cripple Creek district. Farther west are the prominent camps of Victor and Cripple Creek, in which are located some of the famous gold mines of the world. Near Victor are the well known Independence, the Portland and the Ajax Mills, where low-grade Cripple Creek ores are successfully treated.

The plant of the Colorado Fuel and Iron Company, at Pueblo, possesses all the recently invented and approved devices for the production of iron and steel and for the working of these products into marketable forms. At Pueblo are located the Pueblo lead smeltery and the zinc smeltery of the Colorado Zinc Company. At Florence the Union Mill is located. At Canon City is the plant of the Empire Zinc Company. The Ohio and Colorado Smeltery is located at Salida, and the Arkansas Valley Smeltery at Leadville.

In the southwestern part of Colorado is the famous San Juan mining district, which includes the well known camps of Ouray, Telluride, Silverton, and Lake City, where many great mines are located and some of the most efficient milling plants in the world are to be found.

Coal mining is well represented in Colorado by the bituminous mines of the northern coal fields, the anthracite fields of Glenwood Springs, the coal fields of Trinidad, and numerous smaller fields. Oil fields are in operation at Florence and at Boulder.

Many prominent mining camps in neighboring States are easily reached from Golden. Among these are the great copper districts of Montana, Utah, and Arizona, where the latest mining, milling and smelting operations are in progress; the iron mines of Wyoming; and the gold mining camps of South Dakota.

No other mining school in the world has within easy access such a wide variety of mining properties, or such excellent opportunities for observing the latest and best milling and smelting operations.

HISTORY.

The Colorado School of Mines was established by an act of the Territorial Legislature, approved February 9, 1874. Since that time the School has enjoyed a strong and steady growth in buildings, in equipment, in students, in Faculty, and in the strength and rigor of its courses. Additions were made to the original building of 1880, by the building of 1882, and by the building of 1890, all of which are now united and called the Hall of Chemistry. The Hall of Physics was erected in 1894, the Assay Laboratory in 1900, and Stratton Hall in 1904. The Heating, Lighting, and Power Plant was completed in 1906. The Administration Building, named Simon Guggenheim Hall for the donor, was also erected in 1906. The Gymnasium was completed in 1908. The Experimental Ore Dressing and Metallurgical Building was completed in 1912.

ORGANIZATION.

The corporate name of the institution is "The School of Mines." The general management of the School is vested by statute in a Board of Trustees, which consists of five members appointed by the Governor of the State, with the advice and consent of the Senate. The members of the Board of Trustees are appointed in alternating sets of two and three, and hold their office for a period of four years and until their successors are appointed and qualified. The Board of Trustees elects one of its members President. A Secretary and Treasurer are appointed from the Board's number or from without, if deemed advisable. Any three of the Board of Trustees constitute a quorum for the transaction of business. The Constitution of Colorado recognizes the School of Mines as an Institution of the State.

FINANCIAL SUPPORT.

The Colorado School of Mines is supported by the income derived from the annual tax of one-fifth of a mill on each dollar of the assessed valuation of the property in the State. This is known as the "School of Mines Tax." In addition to this, the Legislature from time to time provides such special appropriations as the means of the State treasury permit and the necessities of the School suggest.

BUILDINGS.

SIMON GUGGENHEIM HALL—Administration Building.

This building, the gift of Senator Simon Guggenheim, was erected and furnished at a cost of $80,000. The corner-stone was laid by the A. F. and A. M. of Colorado, October 3, 1905. It is one hundred sixty-four feet long by fifty-seven feet wide and is surmounted by an ornate tower. The first floor is devoted entirely to the department of geology and mineralogy, and includes lecture room, laboratory, office, two work rooms and a public museum; the second floor contains the library, the offices of the President, Secretary, and Registrar, the Faculty room and the Trustees' room; the third floor contains the Assembly Hall, two lecture rooms for mathematics, an office, and the Tau Beta Pi room. The building was dedicated October 17, 1906.

HALL OF CHEMISTRY.

This is a continuous group of brick buildings which comprise the buildings of 1880, 1882, and 1890. The combined buildings of 1880 and 1882 contain the main chemical laboratories. In the building of 1890 are the office and laboratory of the professor of chemistry, the chemical lecture room, the Museum of Applied Chemistry, three recitation rooms, the laboratories for gas and water analysis, and the freshman and sophomore drawing room.

ASSAY BUILDING.

This building, forty-six by ninety-two feet, was built in 1900 with funds contributed by the late W. S. Stratton, and enlarged in 1905 to provide for the installation of a new equipment of gasoline furnaces. The design and equipment of this building make it the best of its kind in the country.

GYMNASIUM.

This building, costing $65,000, was completed in September, 1908. The first floor contains a large swimming pool, shower bath and locker room, finished in white marble and tiling. There is also a room for boxing and wrestling. The second floor contains the offices of the athletic director, athletic board, and secretary of the Y. M. C. A.; and the Integral Club room. The entire third floor is occupied by the gymnasium room proper. This contains fifty-five hundred square feet of clear floor space

and a balcony which provides accommodation for two hundred spectators.

HEATING, LIGHTING, AND POWER HOUSE.

The power plant, erected at a cost of $40,000, is designed to furnish light, heat, and power to the entire school. It is a simple but artistic brick building, eighty-three by one hundred twenty-two feet, with concrete floors and cement roof. The building is divided lengthwise into an engine room thirty-four feet wide, and a boiler room forty-five feet wide. A conduit six feet wide and seven feet high surrounds the engine room below the floor and is used for steam and electric mains. A brick-lined steel stack one hundred twenty-five feet high carries all smoke to the upper air and away from the buildings.

HALL OF PHYSICS.

This building, constructed of red pressed brick, consists of two floors and a basement, and was completed in the Fall of 1894. The upper floor contains two physical laboratories, one for electricity and magnetism and the other for heat and sound, an instrument room, and an office. The physics lecture and apparatus room, the photometry room, the physical laboratory for mechanics and light, the balance and apparatus room as well as a private office and laboratory occupy the first floor. The basement contains the electrometallurgical laboratory, pyrometry and high temperature laboratory, electro-plating room, a magnetic testing laboratory, a laboratory for the study of radioactivity and rare metals by spectroscopic methods, a storage battery room, and a switchboard with connections to all parts of the building.

STRATTON HALL.

The corner-stone of this building was laid by the A. F. and A. M. of Colorado on November 20, 1902, and the building was completed in January, 1904. The basement wall and first story are of Lyons sandstone, in broken ashlar, topped by a story of gray Golden brick. The building is finished on the interior with red pressed brick. Little wood is used, except in the floors and staircases. The basement accommodates the metallurgical and electrical laboratories. The first floor contains two large lecture rooms, each with apparatus room and private office. One-half of the second floor accommodates the surveying and mechanics in one large lecture room, with apparatus room and private office, and the other half contains a drafting room. The third floor is devoted entirely to a large drafting room for the junior and senior classes. The structure was named in honor of the late W. S. Stratton, who contributed $25,000 toward its cost.

THE EXPERIMENTAL ORE DRESSING AND METALLURGICAL BUILDING.

This building, 100 by 150 feet, erected in 1912, was made possible by an appropriation of $75,000 by the Legislature of Colorado. It is situated a short distance from the campus, on the bank of Clear Creek. It is intended to be not only a laboratory for the use of the students in ore dressing and metallurgy, but also a testing plant for the benefit of the mining industry. It is the largest and most complete plant of its kind in the United States.

RESIDENCE OF THE PRESIDENT.

This is a brick building of two and one-half stories. It was built in 1888.

CARPENTER SHOP.

This is well equipped for the special demands which are continually arising in a technical school. The work varies from ordinary repair work to the careful construction of special apparatus needed in the various laboratories.

MACHINE SHOP.

This contains the necessary machinery for the maintenance and repair of equipment and also for the construction of such apparatus as is required for carrying on any new or original work.

LABORATORIES AND EQUIPMENT.

The Experimental Ore Dressing and Metallurgical Plant.

THE BUILDING.

The experimental plant is situated on the bank of Clear Creek, a few blocks from the campus of the School. The building is 98 by 141 feet 8 inches on the ground floor. The framework is of structural steel resting on concrete foundations which have been carried down to a substantial bed of gravel. The walls consist of two and one-half inches of cement mortar, reinforced by "hy-rib," and are of natural cement color. The roof is of elaterite resting on a two-inch sheathing of matched Oregon fir. The ground floor is concrete and is divided into three benches. Above the ground floor, but covering only a part of the area, are two suspended floors of reinforced concrete, supported by steel framework. The building is well lighted and is properly ventilated.

POWER.

All machinery and apparatus requiring power are operated by alternating current motors supplied with current from the power house. For the generation of the current required a producer-gas-power generator unit of 100 kv-a capacity has been installed in the power house. This unit is of Westinghouse design and consists of a bituminous suction gas producer, a vertical three-cylinder gas engine, and a direct-connected alternating current generator.

The producer has a number of noteworthy features. The principal one, and the one which contributes so largely to its success, consists of the two distinct fire zones. This feature makes it possible to operate successfully on very low-grade fuel, and eliminates the difficulties usually arising from the tar and hydrocarbons given off and deposited during the process of gas making. Ordinary Colorado lignite coal is used. From this is produced a cool, clean gas with a heat value of from 115 to 130 B. T. U. a cubic foot. To eliminate the loss of power on account of a reduced intake pressure, a motor-driven, positive-pressure type of exhauster is used. This draws the gas from the producer and delivers it to the engine at a pressure corresponding to about four inches of water.

The engine is of the standard Westinghouse vertical three-cylinder type, single acting, and using a four-stroke cycle. The cylinders are 15 by 14-inch (stroke). At a speed of 257 revolutions per minute, the engine, operating on the producer gas, delivers 118 b. h. p. Compressed air is used for starting, and both engine and producer can be started readily, even though they have stood idle for several days.

Direct-connected to the engine through a flanged coupling is a 100 kv-a, 2,300-volt, three-phase, 60-cycle generator. The current is transmitted at this voltage to the experimental plant where it is stepped down to the working voltage of 440. The installation is such that the 100 kv-a machine can be operated in parallel with a steam turbine in the power house. In case of an emergency all power can be supplied from the turbine alone.

WATER SUPPLY.

A concrete-lined well, 5 feet in diameter by 25 feet deep, has been sunk near the bank of Clear Creek. A 4 by 6-foot tunnel, 120 feet long, extends from the bottom of the well to a stratum of gravel under the bed of the creek. The well and tunnel have a storage capacity of 20,000 gallons. The pumping outfit consists of an automatic motor-driven, submerged-type certifugal pump. This has a capacity of 100 gallons per minute against 50-pound pressure and pumps into pressure storage tanks of 2,500-gallon capacity. An ample supply of clear water is thus assured for all operations.

SECTIONS.

The plant, when fully equipped, will consist of four sections or units—sampling, concentration, cyanidation, and a fourth devoted to roasting and special apparatus, such as magnetic and electrostatic separators, dry tables, and flotation processes. The general equipment includes a Curtis air compressor, a two-stage centrifugal pump, three large water supply tanks operating under air pressure, two motor-operated platform elevators giving control over all the floors, a Ruggles-Coles dryer, ore bins, track scales, turn tables, and ore cars.

The sampling section contains the following equipment: One Vezin sampler, one Brunton sampler, one portable feed hopper, one set of 12 by 20-inch Traylor rolls, one 2 by 6-inch Sturtevant roll jaw crusher, with accessories for finishing the sample such as laboratory crusher and pulverizers, bucking board, and riffles. In addition to this, is a complete oil assay furnace outfit.

The concentrating unit contains one 7 by 10-inch Blake crusher, one 2D Gates gyratory crusher, one set of 14 by 30-inch

P. & M. M. rolls, one set of 12 by 24-inch P. & M. M. rolls, one 3½-foot Huntington mill and one 3½-foot Akron Chilean mill for regrinding, one Richards pulsator jig, one Joplin jig of one compartment, one all-iron Traylor jig of four compartments, one standard Card table, one No. 6 Wilfley table, one Deister sand table, one Deister slime table, one Johnston vanner, one Richards pulsator classifier, one three-compartment classifier, two Callow cones, grizzlies, impact and revolving screens, sampling devices and the necessary sand pumps, elevators, and concentrate driers. In addition, the concentrator contains a battery of five 850-pound gravity stamps, equipped with amalgamating plates, Pierce amalgamator, and clean-up pan. A special feature of this unit is the small-sized apparatus for the handling of small ore lots, i. e., a Callow preliminary ore-testing plant, a quarter-size Wilfley table and a quarter-size Card table. Through this arrangement, ore lots of any size whatever may be tested efficiently.

The cyanide section contains one 4-foot tube mill, one 3½ by 10-foot Pachuca tank, one Paterson agitator, one Dorr classifier, one Dorr thickener, one Dorr agitator, thickening cones, one Moore filter, one Butters filter, one six-compartment zinc box, one lead-lined acid tank, one filter press for zinc slime, solution storage tanks and a small pebble mill. This department is also provided with small-scale apparatus in the shape of agitators and precipitating devices.

In the fourth section provision is made for the installation of special machinery, whereby its efficiency may be tested and comparison made with standard apparatus; for testing by roasting and magnetic or electrostatic separation, by dry tabling, and by such new processes and apparatus as may from time to time come before the metallurgical and mining public.

RESEARCH FEATURES.

Besides supplying the students of the School with a splendid laboratory and thereby increasing the efficiency of their studies, the plant can be used as a research laboratory by the faculty and the alumni of the School. Problems of ore treatment applicable to ores of wide occurrence—problems which affect not only a single mine but a whole district—will be investigated and the results published.

The facilities of the plant also will be available to experts who desire to make investigations of their own. In addition to all this, floor space has been reserved for testing new devices. An inventor who wishes to perfect his invention can have all the facilities of power, water, floor space, ore supply, and expert assistance at his command at a slight expense and will not be obliged to incur the heavy cost of equipping a plant for

his one invention. The plant, then, will serve not only the needs of the School in an educational way, but also will be a means of acquiring much information of great value to the mining industry.

The plant is organized as a department of the School with Professor F. W. Traphagen as director, and in active charge of tests. Practical mill men and skilled mechanicians are employed as the need for them becomes apparent.

An advisory committee for the plant, consisting of the following men, has been appointed: D. W. Brunton, Denver, Colo., mining engineer; Philip Argall, Denver, Colo., manager, Stratton's Independence; John Tait Milliken, Colorado Springs, Colo., consulting engineer; Thomas B. Crowe, Victor, Colo., superintendent, New Portland Mill; Walter G. Swart, Denver, Colo., western representative, American Zinc Ore Separating Company.

COLLECTION OF COMMERCIAL ORES.

Most collections of ores are classified according to their mineral contents, but the department of mining is pursuing the policy of gathering average ore samples from every mining district. These are arranged geographically so that the typical ores of each mining district are placed together. Such an arrangement is found to be of great educational value to the classes in mining. The collection now numbers about 1,250 specimens.

MINERALOGICAL AND GEOLOGICAL LABORATORY AND CABINET.

Under the name cabinet is embraced not only the display collections, which may perhaps be called the cabinet proper, but also the other collections that have been prepared mainly for the purpose of class instruction. These collections are necessarily changing from year to year, as new material is constantly being added. This new material is obtained partly by purchase, but mainly by direct collecting, by gifts, and by means of exchange with other institutions. The display collections are not thoroughly classified, but are arranged in different cases with a view to displaying certain groups of minerals, or minerals from certain localities. The various collections, which together contain sixty-six thousand specimens, consist of display, type, and working or study collections of minerals, fossils, rocks, and ores. The rock collections include a general collection from different countries, one devoted to Colorado localities, and still others that cover particular countries or localities.

EXCHANGES.

The School has prepared a printed list of exchange material, covering both minerals and rocks. The list will be sent to all who wish to arrange for exchanges. Correspondents should state what material they are prepared to offer in exchange. Letters should be addressed to Professor H. B. Patton, Golden, Colorado.

MINERALOGICAL LABORATORY.

Aside from the special advantages due to location, the department of geology is admirably equipped for practical teaching. The entire first floor of Guggenheim Hall is occupied by this department. The south end of the building is occupied by a commodious lecture room, with a seating capacity of more than a hundred, and by a separate mineralogical laboratory with table space for between fifty and sixty students, also by two small recitation rooms. On the extreme north end of the building is the public museum, devoted to a display of fine minerals. Additional space is provided for working rooms, offices, packing, and storage rooms.

METALLURGICAL COLLECTIONS.

The School has a fine collection of models from the works of Theodore Gersdorf, Freiberg, Saxony, which illustrate the best type of furnaces in this and other countries. Each model is made to scale and is complete in every detail. In addition to these models are the following to illustrate the best modern practice: Working model of a twenty-stamp mill, on a scale of one and one-half inches to the foot; working model of crushing rolls; working model of a Dodge crusher; model of modern blast furnace for lead-silver ores, with water jacket; smaller models, such as the complete set used in the famous Keyes and Arents lead-well suit. There is also a large collection of ores, ore dressing and metallurgical samples and products.

METALLURGICAL LABORATORY.

This laboratory is equipped with apparatus for the study of the quantitative relations of the various agencies taking part in metallurgical changes. The Junker, the Mahler Bomb, and the Parr calorimeters, the Wanner optical, the Le Chatelier, and Bristol electrical pyrometers, together with sets of the American Gas Furnace Company's gas furnaces, and Hoskin's gasoline furnaces are used for obtaining the desired temperature for experimentation. These furnaces also serve for the necessary assaying demanded in the metallurgical laboratory. Desks and apparatus are provided for small scale work in amalgamation,

chlorination, and cyanidation; for larger scale work a battery of eight amalgamation pans, devised to be operated together or independently by power, several sets of cyanide tanks, including a Braun Laboratory Cyanide plant, and a chlorination barrel, are provided. There is also a Hendryx combined agitator and filter, and a Hendryx agitator for hydro-metallurgical treatment of copper ores, dry chlorination apparatus, and a Paterson agitator for cyaniding slime. Provision for large scale work is made in the Experimental Ore Dressing and Metallurgical Plant.

ASSAY LABORATORY.

This laboratory is well equipped with parting, balance, and store rooms and office, and thirty-two coal-fired muffle furnaces. Each student has his own muffle, with his own coal bin, pulp balance, and desk, conveniently arranged with regard to his furnace; he has also access in the balance room to the best type of assay and pulp balances. The equipment of gasoline furnaces includes one crucible, four combination, and three muffle furnaces, one crude oil burner, one tempering furnace, and a bullion and tempering furnace, all of the F. W. Braun & Co. type; also three Case muffle furnaces, one improved Case high temperature muffle, and one Case crucible furnace, two Braun cupel machines, two Iler cupel machines and two bullion rolls, one of which is of the Braun type. In order to avoid dust, change of temperature, and direct sunlight, the balance room has no outside walls, and is lighted by means of skylights. The equipment here includes four special pulp balances, five silver balances, three gold balances, one Thompson multiple rider balance, and one Mine & Smelter Supply Company button balance, Wilfrid Heusser type, No. 1,000, sensitive to 1-500 milligram. This variety is selected in order to acquaint the student with the various mechanisms and adjustments in assay balances.

SURVEYING EQUIPMENT.

The equipment of the department of surveying is well adapted to the practical course given. For transit work there are twenty-five light mountain transits, of which six are provided with solar attachments for determining the meridian and latitude, and eleven with auxiliary telescopes for underground work. There are also three heavy transits, one of which is of English and one of German make. In addition to the transits there are two plane tables for taking topography. For leveling, seven wye levels and five dumpy levels of standard manufacture are used. The department is well supplied with leveling rods of various makes and types, stadia rods, hand levels, clino-

meters, flagpoles, and other accessories. The instruments are manufactured by such well known firms as C. L. Berger & Sons, Buff & Buff, Heller & Brightly, Eugene Dietzgen & Co., Peter Heer & Co., W. and L. E. Gurley, Keuffel & Esser, William Ainsworth & Sons, Weiss & Heitzler, Young & Sons, Negretti & Zambra (English), and Max Hildebrand (German).

MUSEUM OF APPLIED CHEMISTRY.

The Museum of Applied Chemistry is on the first floor of the Hall of Chemistry. The object in establishing this museum is to aid, in a practical way, the courses in applied chemistry and metallurgy. Mounted specimens of raw materials, main products, by-products, and waste products of the various branches of technical chemistry and metallurgy are a direct stimulus in the study of these branches. The specimens already collected for the museum represent, among other things, the various stages of the manufacture of brick, fire-brick, tile, cement, electrolytic alkalis, natural alkalis, electric furnace products, carborundum, alundum, carbide, rare metals, ferro-alloys, and white lead.

CHEMICAL LABORATORIES.

The freshman, sophomore, and junior laboratories accommodate two hundred ninety-five students, and are equipped with especially designed tile-topped oak desks, provided with low reagent shelves, gas, water, filter pumps, and large porcelain sinks. The balance rooms are equipped with Sartorius, Becker, and Spoerhase balances. Gas is supplied to the building from a 300-light Detroit gas machine, which is connected with buried supply tanks outside the buildings. Good ventilation is obtained by means of two Sturtevant fans.

Gas Analysis Laboratory. This laboratory contains a Lothar Meyer modification of the Bunsen eudiometer and a cathetometer, a complete Hemple and Elliott outfit, together with special apparatus for the collecting, storing, and handling of gases.

Water Analysis Laboratory. This laboratory adjoins and communicates with the gas analysis laboratory, and contains a full equipment of ordinary and special apparatus for water analysis. It is situated apart from the general laboratories and is particularly free from contaminating fumes.

HYDRAULIC LABORATORY.

The hydraulic laboratory contains weirs and orifice tanks for the determination of coefficients of discharge, calibrated tanks for water measurement, a steel pressure tank for artificial heads, pumps for water supply, and gages for pressure. A

hydraulic ram is used to illustrate this class of apparatus and for testing. A long sheet-iron trough with a car over it is used for calibrating current meters. Water wheels and centrifugal pumps are tested for efficiency under various conditions of head and load. A swinging tank is used to measure jet reactions. Friction losses in pipes and elbows are measured. Hook gages are used for the accurate determination of low heads. Streams and ditches in the vicinity of Golden are gaged by means of the current meter, by rod floats, by slope, and by a Pitot tube.

PHYSICAL LABORATORIES.

The three physical laboratories are in the Hall of Physics. The laboratory for mechanics and light is on the first floor. Adjoining is a balance and instrument room and a dark room containing a complete Lummer-Brodhun photometer and an optical bench. On the second floor are the laboratories for electricity and magnetism, and for heat and sound. The equipment is particularly adapted to the instruction of students of engineering, and is designed to teach the principles of elasticity and efficiency of machines, composition and resolution of forces, various forms of motion, density, velocity and pitch of sound, focal length of lenses, magnifying power, and the principles of the construction of telescopes. The heat laboratory is particularly well equipped for calorimetry, heat expansion determinations, and for the determining of the mechanical equivalent of heat. A complete line of galvanometers, standard resistances, condensers, ammeters, voltmeters, dynamometers, permeameters, standard cells, and a Kelvin balance compose the electrical apparatus; in magnetism all the principles which underlie the construction of magnets for lifting purposes and for the separation of ores are demonstrated in the laboratory.

ELECTROMETALLURGICAL LABORATORY.

The electrometallurgical laboratory is in the basement of the Hall of Physics. It consists of a main room, adjoining which are the storage battery room, a room for cleaning, polishing, and electroplating, and a room for pyrometry and high temperature work. The main laboratory covers a space 25 by 45 feet and contains sixteen desks. All desks are equipped with voltmeters, ammeters, rheostats, and terminals leading to a central switchboard where connections may be made to a full set of storage cells or to direct or alternating current, and to two large wire rheostats. Besides platinum electrodes, stirring devices, rotating anodes, and such chemical apparatus as is necessary for electro-chemistry, there is a complete equipment of electrical apparatus for studying the principles and conditions involved in electrolytic plants and in electric furnace work.

When a student has completed this course it is expected that he will be in a position to investigate and to understand all the conditions relating to an electrolytic plant, such as density of solutions, temperature effects, and the nature of different electrodes and electrolytes, also all the principles involved in the use and correction of pyrometers, the conversion of electrical energy into heat, and the efficiency of electrical furnaces. All the apparatus is so arranged that it may be used for research and investigation work.

MECHANICS OF ENGINEERING LABORATORY.

The laboratory is provided with a motor-driven 100,000-pound Riehle testing machine arranged for experiments in tension, compression, shearing, and flexure of materials of construction. Extensometers for measuring elongations and compressions are employed. Numerous steel sections provide useful problems in determining centers of gravity and moments of inertia.

The equipment for cement testing includes a 2,000-pound Riehle testing machine for testing briquettes in tension. Scales and volumeters are provided for measuring quantities in bulk. The specific gravity of cement is determined by means of Le Chatelier apparatus. A nest of fineness sieves and a set of very sensitive scales equip the student for the fineness test. Setting is determined by means of the complete Vicat apparatus. Trowels, spatulas, large slate-mixing boards, breakers, moulds, damp box, and immersing vats, provide apparatus for the making and setting of briquettes and for the soundness tests. Moulds are used for making cubes of concrete for compression tests. The use of reinforced concrete is illustrated by complete models of forms for the manufacture of reinforced concrete columns and beams, and by numerous samples of various types of reinforcing bars.

ELECTRICAL LABORATORY.

This laboratory is equipped with standard voltmeters, ammeters and wattmeters, inductive and non-inductive resistances or artificial loads, a Thompson apparatus for induction experiments, a slip indicator for induction motors, an automatic speed recorder which can be used for finding the acceleration curves of motors, an Alden absorption dynamometer for motor testing, a contact apparatus for alternating current and voltage wave form, a split phase rotary field apparatus, a 10,000 volt oil switch in a glass receptable so that its action may be observed, a horn break cutout, tank and transformers used in insulator tests. The generators available for laboratory work include a 100 kv-a 2,300 volt, 60 cycle, 3 phase Westinghouse alternator, driven by

a Westinghouse producer gas engine, a 75 kw. 240 volt, 3 wire, d. c. Westinghouse generator, driven by a 112 h. p. 2,300 volt, 3 phase, synchronous motor, a 75 kw. Bullock twin unit continuous current generator set, driven by a 110 h. p. De Laval turbine, a 30 kw. 1,100 volt, 125 cycle, single phase General Electric alternator, a 15 kw. 130 volt compound, continuous current generator designed and built at the school, an 8 kw. Crocker-Wheeler generator, a 6 kw. 130 volt Westinghouse generator, a 2 kw. 120 volt compound Brush machine, a series arc light machine, and a small Edison shunt generator. The Bullock generators can be connected at the switchboard to supply the 120-240 volt 3 wire lighting and power circuits, or they can be put in parallel and thus supply more than 600 amperes for electrothermic work. The motors include a 10 h. p. 220 volt, 60 cycle, 3 phase constant speed induction motor of General Electric make, two 5 h. p. series motors with controllers, a 5 h. p. 3 phase, two-speed induction motor, used for electric drilling, a 4 h. p. single-phase Wagner motor, a 400-2000 rev. per min. variable speed experimental motor designed and built at the school, a 20 h. p. series motor, and a large number of 3 phase motors and shunt machines of standard makes in daily use about the shops and buildings. The storage batteries of 54 cells each are in daily use and are available for study. In addition to these generators and motors, a modern 5 panel d. c. switchboard and 7 panel a. c. and d. c. switchboard with the usual instruments, switches, and auxiliaries, afford excellent opportunities for the study of electric plant equipment. The work in electrical measurements and instrument testing is done in a special laboratory in the Hall of Physics. The engine room is utilized as a part of the dynamo laboratory, but the laboratory in Stratton Hall, equipped with numerous circuit outlets and portable instruments, is used chiefly for the study of motors and their auxiliaries.

MINING LABORATORY.

The laboratory work in mining is carried on principally at the tunnel belonging to the School. The equipment here consists of numerous drills which are taken apart, reassembled, and used by the student; forges, anvils and tools for blacksmithing; the air receiver, valves, gages, fuses and switches connected with the compressed air and electric power transmission from the power plant; two mining cars; materials for track laying; and all other supplies usually found at a tunnel house. Among the makes of rock drills used by the students are Rand, Ingersoll, Sergeant, Leyner, McKiernan, Wood, Hardsocg, Shaw, Waugh, and Temple-Ingersoll. All of the mountings, such as bars, tripods, and arms, and a supply of drill steel, are also

provided. In the laboratory at the School are two working size models of the Bleichert system of aerial trams; numerous models of mines; an explosive tester; a collection of rock cores taken by diamond drills; models of timbering methods; many mine maps; instruments for measuring ventilation; lantern slides illustrating mining operations; samples of wire ropes and drill steels, lamps of the open and safety patterns; a dry placering machine; and many photographs of mines and operations.

LABORATORIES IN RADIOACTIVITY AND SPECTROSCOPY.

In radioactivity, the laboratory is well equipped with emanation, alpha, beta, gamma, and field electroscopes, quadrant electrometers and electric furnaces. There is all the necessary apparatus for making radioactive determinations of minerals by the solution or fusion methods and also measuring the radioactivity of spring waters. Measurements have been made possible by standards which the United States Bureau of Mines have made and presented to the Colorado School of Mines.

The equipment in spectroscopy consists of spectrometers, spectrographs, and all such auxiliary apparatus as will give one the experimental development leading finally up to work on the large fifteen-foot Littrow type of spectrograph. A study of the theory, and use of the spectroscope is made so as to make measurements and determinations of the spectra of various metals, mainly the rare metals. There is a laboratory especially equipped for whatever chemical and electrochemical work may be necessary in connection with this work.

MECHANICAL ENGINEERING LABORATORY.

The heating, lighting, and power plant is well equipped for mechanical engineering laboratory practice. The boiler room contains the following principal equipment: One 200 h. p. and one 100 h. p. Babcock & Wilcox water tube boilers, each equipped with a chain grate; one 80 h. p. tubular boiler equipped with plain grate; Green Engineering Company fuel economizers; Babcock & Wilcox independently fired super-heater; Webster feed-water heater, boiler feed and vacuum pumps and injectors; one Wilcox water weigher; a 125 by 5-foot self-supporting steel stack supplemented by a steam-driven 42-inch Sirocco fan for induced draft; eight 25-ton steel bunkers for coal storage; and a 125 h. p. Westinghouse double-flow gas producer equipped with wet and dry scrubbers, mixing and gas storage tank, and motor-driven exhauster.

The engine room contains the following principal apparatus: 10 by 12-inch high speed Russell engine; 6 by 9-inch throttling Sturtevant engine; 75kw. De Laval steam turbine geared to twin generators; 7 by 6-inch two-cylinder vertical Westinghouse

Jr. engine; 15 by 14-inch three-cylinder vertical Westinghouse gas engine direct connected to alternator; 6¾ by 14-inch single Fairbanks, Morse & Company gas engine; 8¾ by 14-inch Priestman oil engine; a J. George Leyner Engineering Works two-stage air compressor—capacity 275 cubic feet of free air per minute; and a small Westinghouse air-brake.

The laboratory is well equipped with auxiliary apparatus such as indicators, prony brakes, Orsat apparatus, calorimeters, manometers, etc., for conducting experimental work.

DRAWING ROOMS.

Freshman and Sophomore. This occupies the upper floor of the Hall of Chemistry. The floor area is about four thousand square feet. It is lighted by windows on the north, east, and west, and by eight large skylights in the roof. A suitable office for the instructors is in a central position, in which all drawings are filed and all records are kept. Each student is provided with a drawing table, a drawer, a drawing board, and a stool. The present equipment accommodates about one hundred fifty students. There are many models to aid the students in their work.

Junior and Senior. The entire third floor of Stratton Hall is used for the junior and senior drawing. The room is 90 by 60 feet, lighted by windows and a large skylight. Each student is provided with a drawing table, a drawer, a drawing board, and a stool. Most of the drawing tables are independent and adjustable. The room has recently been equipped with especially constructed tables for the advanced work of the seniors. The present equipment accommodates about one hundred sixty students. There is a blue-print room fully equipped with an adjustable printing frame and all other necessary appliances. In one corner of the room is the offce of the instructors, where all drawings and records are filed. There are for the use of the students a complete set of trade catalogues and a great many blue prints from outside concerns. These are kept up to date. One-half of the second floor of Stratton Hall is used as a drawing room for the senior class.

REQUIREMENTS FOR ENTRANCE.

FRESHMAN CLASS.

Unit Course. A unit course of study is defined as a course covering a school year of not less than thirty-six weeks, with five weekly periods of at least forty-five minutes each.

Fifteen Units are required for entrance, of which twelve are specified and three may be chosen from a list of electives.

Specified Units.

Essentials of Algebra	1	unit
Advanced Algebra	½	unit
Plane Geometry	1	unit
Solid Geometry	½	unit
Languages, other than English	2	units
English	3	units
History	2	units
Physics	1	unit
Chemistry	1	unit
Specified Units	12	
Elective Units	3	
Total Units for Entrance	15	

Elective Units.

The three elective units may be selected from the following list: Drawing, Shop Work, Mathematics, Latin, Greek, French, German, Spanish, History, English, Science, Psychology, Political Economy. In allowing credit for drawing and shop work two forty-five minute periods will be regarded as equivalent to one forty-five minute period of classroom work. Half units are accepted in all studies except in physics and chemistry, provided that not less than one full unit shall be accepted in language.

Entrance.

(a) By Certificate.

A graduate of an Accredited High School in the State of Colorado will be admitted without examination upon the presentation of proper credentials from the principal of his high school, provided that the studies he has completed successfully cover the requirements for entrance. Blanks for this purpose will be sent, on application to the President.

Graduates of accredited high schools in other states will be accepted in the same manner as graduates of accredited high schools in Colorado.

(b) By Examination.

All other candidates for admission will be required to pass entrance examinations. These examinations are held in Golden.

For the benefit of any student who can not take the examination in Golden, conveniently, on account of the distance, arrangements will be made so that he may take the examination under the direction of some responsible person at his own home, or near it.

Entrance examinations for the class of 1918 will be held in Golden on Wednesday, Thursday, and Friday, September 2, 3, and 4, 1914.

Entrance examinations for the class of 1919 will be held in Golden on Wednesday, Thursday, and Friday, September 1, 2, and 3, 1915.

It is the opinion of the Faculty of the Colorado School of Mines that every candidate for the freshman class should have taken a thorough course of at least four years in a good high school, or its equivalent, and during the last year of his preparation should have had a thorough review of mathematics. Special attention should be given to the preparation in chemistry and physics.

DESCRIPTION OF THE UNITS REQUIRED FOR ENTRANCE.

ENGLISH (3 Units).

(a) **Grammar.** The student should have a sufficient knowledge of English grammar to enable him to point out the syntactical structure of any sentence which he meets in the prescribed reading. He should also be able to state intelligently the leading grammatical principles when he is called upon to do so.

(b) **Reading.** The books prescribed by the Joint Committee on Uniform Entrance Requirements in English form the basis for this part of the work.

The list is divided into two parts: the first consists of books to be read with attention to their contents rather than to their form; the second consists of books to be studied thoroughly and minutely.

The lists thus divided are as follows:

I. Books prescribed for reading.

Group I. (Two to be selected).

Shakespeare's *As You Like It, Henry V, Julius Caesar, The Merchant of Venice, Twelfth Night.*

Group II. (One to be selected).

Bacon's *Essays;* Irving's *Life of Washington; The Sir Roger de Coverley Papers* in *The Spectator; Franklin's Autobiography.*

Group III. (One to be selected).

Chaucer's *Prologue;* Spencer's *Faerie Queene* (selections); Pope's *The Rape of the Lock;* Goldsmith's *The Deserted Village;* Palgrave's *Golden Treasury* (*First Series*), *Books II and III,* with especial attention to Dryden, Collins, Gray, Cowper and Burns.

Group IV. (Two to be selected).

Goldsmith's *The Vicar of Wakefield;* Scott's *Ivanhoe;* Scott's *Quentin Durward;* Hawthorne's *The House of the Seven Gables;* Thackeray's *Vanity Fair;* Mrs. Gaskell's *Cranford;* Dickens' *A Tale of Two Cities;* George Eliot's *Silas Marner;* Blackmore's *Lorna Doone.*

Group V. (Two to be selected).

Irving's *Sketch Book;* Lamb's *Essays of Elia;* De Quincey's *Joan of Arc* and *The English Mail Coach;* Carlyle's *Heroes and Hero Worship;* Emerson's *Essays;* Ruskin's *Sesame and Lilies.*

Group VI. (Two to be selected.)

Coleridge's *The Ancient Mariner;* Scott's *The Lady of the Lake;* Byron's *Mazeppa* and *The Prisoner of Chillon;* Palgrave's *Golden Treasury* (*First Series*), *Book IV,* with especial attention to Wordsworth, Keats and Shelley; Macaulay's *Lays of Ancient Rome;* Poe's *Poems;* Lowell's *The Vision of Sir Launfal;* Arnold's *Sohrab and Rustum;* Longfellow's *Evangeline;* Tennyson's *Gareth and Lynette, Lancelot and Elaine,* and *The Passing of Arthur;* Browning's *Cavalier Tunes, The Lost Leader, How They Brought the Good News from Ghent to Aix, Evelyn Hope, Home Thoughts from Abroad, Home Thoughts from the Sea, Incident of the French Camp, The Boy and the Angel, One Word More, Herve Riel, Pheidippides.*

II. Books prescribed for study and practice.

Shakespeare's *Macbeth,* Milton's *Lycidas, Comus, L'Allegro,* and *Il Penseroso;* Burke's *Speech on Conciliation with America* or Washington's *Farewell Address* and Webster's *First Bunker Hill Oration;* Macaulay's *Life of Johnson,* or Carlyle's *Essay on Burns.*

(c) **Composition.** Regular and persistent training in both writen and oral composition should be given throughout the entire school course. The topics should be so chosen as to give practice in the four leading types of prose discourse, namely, description, narration, exposition, and argument.

(d) **Rhetoric.** The instruction in this subject should include the following particulars: Choice of words, structure of sentences and paragraphs, the principles of narration, description, exposition and argument.

The teacher should distingulsh between those parts of rhetorical theory which are retained in text books merely through the influence of tradition and those which have a direct bearing upon the composition work. The former may be safely omitted.

HISTORY (2 Units).

Any two of the following periods may be offered:

I. Ancient History, with special reference to Greek and Roman History, with a short introductory study of the more ancient nations and the chief events of the early middle ages, down to the death of Charlemagne.

II. Mediaeval and Modern European History, from the death of Charlemagne to the present time.

III. English History.

IV. American History, or American History and Civil Government.

MATHEMATICS (3 Units).

The courses offered by the school are so exacting that a thorough training in the following prerequisites is essential. Students found deficient in any of these subjects will be assigned to special classes, provided by the school, to remove such deficiencies in addition to the regular freshman work in mathematics, and in no case will a student be permitted to proceed with the full freshman schedule if he be judged deficient in algebra and solid geometry. The regular courses are so arranged that an ambitious student with mathematical tendencies, even though compelled to enlist in such extra work, may complete the entire freshman schedule in mathematics before the beginning of the sophomore year.

I. **Essentials of Algebra.** (I Unit). The four fundamental operations for rational algebraic expressions; factoring; complex fractions; the solution of equations of the first degree containing one or more unknown quantities; radicals; theory of indices; quadratic equations and equations containing one or more unknown quantities that can be solved by the methods of quadratic equations; problems dependent on such equations.

II. **Advanced Algebra.** (½ Unit). This course should begin with a thorough review of the essentials. Later work should cover an introduction to the graphical representation of linear and simple quadratic expressions; ratio and proportion; variation; binomial theorem; the progressions, and logarithms.

III. **Plane Geometry.** (1 Unit). Completed, with the solution of original exercises and numerical problems.

IV. **Solid Geometry.** (½ Unit.) Properties of straight lines and planes; of dihedral and polyhedral angles; of projection; of polyhedrons, including prisms; of pyramids and the

regular solids; of cylinders, cones and spheres; of spherical triangles, and the mensuration of surfaces and solids.

CHEMISTRY (1 Unit).

The equivalent of Brownlee's **Elementary Chemistry**, Bradbury's **Elementary Chemistry** or Remsen's **Briefer Course of Inorganic Chemistry**, with experiments.

PHYSICS (1 Unit).

The equivalent of Carhart and Chute's **High School Physics**, or Gage's **Principles of Physics**, together with systematic laboratory practice such as is outlined in Crew and Tatnall's **Laboratory Manual in Physics.**

The two units required in languages other than English may be offered in Greek, Latin, French, German, or Spanish.

ADMISSION TO ADVANCED STANDING.

Applicants who are graduates of technical or scientific schools or colleges of good standing will be admitted without examination upon the presentation of proper credentials. They will be permitted to take any subject taught in connection with the regular courses, provided, in the opinion of the instructor, their previous experience and training will enable them to pursue the subject with profit. Each case will be judged on its own merits, but applicants will be advised to become candidates for a degree and to complete one of the regular courses of the school.

Applicants who have partially completed the course in technical or scientific schools or colleges of good standing will be admitted without examination upon the presentation of proper credentials. Due credit will be allowed for the successful completion of work which is equivalent to that given in the Colorado School of Mines. Plates of drawings, laboratory note books, and catalogues of the institution attended, should be submitted with applications for advanced standing. **This school does not admit special students.** Each applicant for advanced standing is expected to enroll in one of the regular courses and to become a candidate for a degree. All credits given to advanced standing students are given provisionally, with the understanding that such credits may be withdrawn at any time in case a student fails to maintain a creditable standing. Application blanks will be furnished, on request to the President.

DEGREES.

The degree of E. M. (Engineer of Mines) will be conferred upon a candidate who fulfills the following conditions:

(a) He must complete the prescribed work of the freshman and sophomore years.

(b) He must complete the prescribed work in one of the two groups: Mining or Metallurgy.

(c) He must complete enough additional work to make a total of 100 credit hours for the junior and senior years.

(d) He must take the senior trip and present an acceptable thesis.

Each senior must submit to the Faculty, not later than November 1, the subject of his thesis, which must be approved by the professor concerned. Each thesis must be typewritten or printed on eight and one-half by eleven-inch paper, bound in book form, and submitted not later than March 1.

No diploma will be delivered until the thesis is handed in, the full requirements of the course of study are satisfied, and all accounts with the school are settled.

The degree of M. S. (Master of Science) will be conferred upon a candidate who already holds a degree from this School or its equivalent, according to the standard of the Colorado School of Mines, and whose application for such degree shall have been approved by the Faculty; provided that the candidate completes work equivalent to fifty credit hours, chosen with the approval of the Faculty from either the postgraduate or undergraduate courses, and presents an acceptable thesis. It is required that the candidate shall select and complete not less than fifteen credit hours in at least one of the following departments, namely, Mining, Metallurgy, Geology, and Chemistry.

DEPARTMENTS OF INSTRUCTION.

TABULAR VIEW.

FRESHMAN YEAR.

REQUIRED OF ALL STUDENTS.

FIRST SEMESTER.	Course No.	Lect. Hrs.	Lab. Hrs.
General Geology, (p. 70)	51	3	
Descriptive Geometry, (p. 84)	127	2	9
General Chemistry, (p. 92)	151	5	
Qualitative Analysis, (p. 92)	153	1	3
Advanced Algebra, (p 101)	205	3	
Plane Trigonometry, (p. 102)	207	2	
English, (p. 107)	227	2	

SECOND SEMESTER.	Course No.	Lect. Hrs.	Lab. Hrs.
General Geology, (p. 71)	52	3	
Descriptive Geometry, (p. 84)	128	2	6
General Chemistry, (p. 92)	152	4	
Qualitative Analysis, (p. 93)	154	2	11
Analytic Geometry, (p. 103)	212	4	
Spherical Trigonometry, (p. 102)	208	1	
English, (p. 107)	228	1	

TABULAR VIEW.

SOPHOMORE YEAR.

REQUIRED OF ALL STUDENTS.

FIRST SEMESTER.	Course No.	Lect. Hrs.	Lab. Hrs.
Crystallography, (p. 71)	53	2	6
Machine Design, (p. 85)	129	2	3
Quantitative Analysis, (p. 93)	155	1	9
Industrial Chemistry, (p. 95)	157	2	
Physics, (p. 98)	177	5	4
Calculus, (p. 103)	213	5	
English, (p. 107)	229	1	

SECOND SEMESTER.	Course No.	Lect. Hrs.	Lab. Hrs.
Mineralogy, (p. 71)	54	2	6
Machine Design, (p. 85)	130	2	3
Plane Surveying, (p. 76)	76	1	
Quantitative Analysis, (p. 94)	156	1	6
Industrial Chemistry, (p. 95)	158	2	
Physics, (p. 99)	178	5	4
Calculus, (p. 103)	214	5	
English, (p. 107)	230	1	

Plane Surveying: Course 76a, p. 76, credit 5 hours. Six weeks in the summer following the regular school year.

TABULAR VIEW.

JUNIOR YEAR.

MINING.

FIRST SEMESTER.	Course No.	Lect. Hrs.	Lab. Hrs.
Mineral Land Surveying, (p. 52)	1	2	
Placer Mining, (p. 54)	5	3	
Mine Accounting, (p. 54)	7	1	
Metallurgy of Iron and Steel, (p. 61)	29	3	
Historical Geology, (p. 72)	55	4	
Mechanics, (p. 77)	77	4	
Direct Currents, (p. 81)	101	3	6
Heat Engines, (p. 86)	131	1	6

SECOND SEMESTER.	Course No.	Lect. Hrs.	Lab. Hrs.
Mine Surveying, (p. 52)	2	2	
First Aid Work, (p. 54)	6	1	
Metallurgy of Lead, (p. 62)	30	2	
Assaying, (p. 61)	28	1	8
Lithology, (p. 72)	56	2	3
Mechanics, (p. 77)	78	3	
Hydrostatics, (p. 78)	82	1	
Testing Laboratory, (p. 78)	80		3
Alternating Currents, (p. 81)	102	3	3
Heat Engines, (p. 87)	132	2	3

Mine Surveying: Course 4, p. 53, credit 3 hours. Four weeks in the summer following the regular school year.

TABULAR VIEW.

JUNIOR YEAR.

METALLURGY.

FIRST SEMESTER.	Course No.	Lect. Hrs.	Lab Hrs.
Mineral Land Surveying, (p. 52)	1	2	
Mine Accounting, (p. 54).....	7	1	
Assaying, (p. 60).....	27	1	11
Metallurgy of Iron and Steel, (p. 62)..	31	4	
Historical Geology, (p. 73)	57	2	
Mechanics, (p. 77)	77	4	
Direct Currents, (p. 81)	101	3	3
Heat Engines, (p. 86)	131	1	3
Stoichiometry, (p. 96)	163	1	

SECOND SEMESTER.	Course No.	Lect. Hrs.	Lab. Hrs.
Mine Surveying, (p. 52)	2	2	
First Aid Work, (p. 54)	6	1	
Metallurgy of Lead and Zinc, (p. 63)..	32	4	
Lithology, (p. 72)	56	2	3
Mechanics, (p. 77)	78	3	
Hydrostatics, (p. 78)	82	1	
Alternating Currents, (p. 81)	102	3	6
Heat Engines, (p. 87)	132	2	
Metallurgical Chemistry, (p. 95).....	160	1	5
Stoichiometry, (p. 96)	164	1	

Mine Surveying: Course 4, p. 53, credit 3 hours. Four weeks in the summer following the regular school year.

TABULAR VIEW.

SENIOR YEAR.

MINING.

FIRST SEMESTER.	Course No.	Lect. Hrs.	Lab. Hrs.
Mineral Land Surveying, (p. 53).....	3		3
Metal Mining, (p. 55)	9	2	
Mine Examinations and Reports, (p. 57)	15	2	
Coal Mining, (p. 57)	13	2	
Mining Law, (p. 111)	251	1	
Ore Dressing, (p. 63)	33	4	3
Economic Geology, (p. 75)	63	3	
Hydraulics, (p. 78).....	83	2	3
Compressed Air and Pumps, (p. 87)..	133	3	
Steam Laboratory, (p. 88)	135		3
Thesis, ...			3

SECOND SEMESTER.	Course No.	Lect. Hrs.	Lab. Hrs.
Metal Mining, (p. 55)	10	2	
Economics of Mining, (p. 58).....	16	2	
Mine Management, (p. 58).....	18	2	
Coal Mining, (p. 58).....	14	2	
Metallurgy of Copper, Gold, etc., (p. 64)	36	5	3
Economic Geology, (p. 75)	64	3	
Power Plant Design, (p. 88).....	134	2	6
Thesis, ...			6

TABULAR VIEW.

SENIOR YEAR.

METALLURGY.

FIRST SEMESTER.	Course No.	Lect. Hrs.	Lab. Hrs.
Mineral Land Surveying, (p. 53)	3		3
Metal Mining, (p. 55)	9	2	
Mine Examinations and Reports, (p. 57)	15	2	
Ore Dressing, (p. 63).....	33	4	3
Metallurgy of Nickel, etc., (p. 64) ...	35	3	
Metallurgical Laboratory, (p. 65)....	37		3
Electrometallurgy, (p. 66).....	39	2	3
Metallography, (p. 67).....	41	1	
Economic Geology, (p. 75)	63	3	
Theoretical Chemistry, (p. 97).....	165	2	
Thesis, ...			3

SECOND SEMESTER.	Course No.	Lect. Hrs.	Lab. Hrs.
Metal Mining, (p. 55)	10	2	
Economics of Mining, (p. 58)	16	2	
Metallurgy of Copper, Gold, (p. 64)...	36	5	3
Electrometallurgy, (p. 68)	44	3	
Metallography, (p. 67).....	42		3
Economic Geology, (p. 75).....	64	3	
Theoretical Chemistry, (p. 97).....	166	2	
Thesis, ...			6

MINING.

Professor Harry John Wolf.
Assistant Professor William Reuel Chedsey.
Instructor Ralph Roy Knowles.

1. MINERAL LAND SURVEYING. Lectures.

Credit two hours.

This course covers instruction in the methods of acquiring title to mineral lands in the United States and in foreign countries. Special attention is given to practice in the western United States. Determination of Meridian and Latitude by solar and stellar observations is explained. Methods of sub-dividing the public lands and the regulations of land offices and Surveyors General are discussed and explained. Instruction is given in the preparation and filing of the documents used in acquiring title to lode and placer claims; mill and tunnel sites; timber, coal and stone lands; water rights; dam and reservoir sites; and ditch, flume and pipe lines. The duties of the United States Deputy Mineral Surveyors are explained and the student is familiarized with the field methods and office practice involved in obtaining United States Patent to mineral lands. This course makes the student competent to pass the examination given by the Surveyor General to applicants for commissions as mineral surveyors.

Prerequisites: The completed work of the freshman and sophomore years, except Course 213, Calculus, which must accompany, if not already completed; and Course 76, Plane Surveying.

Two hours a week during the first semester of the junior year.

(Chedsey.)

2. MINE SURVEYING. Lectures.

Credit two hours.

This course includes the theory involved in mine surveying. Among the subjects discussed are the following: The adjustment and uses of top and side telescopes and other transit accessories used in underground work; surface and underground surveys and traverses; carrying the meridian underground; underground connections; plumbing vertical shafts; determina-

tion of dip, strike and thickness of mineral deposits from results of development, including drill-hole data; survey and measurement of stopes, rooms and pits; methods of recording surveys in field books and office records; methods of mapping, including plans, elevations, and sections of underground workings, and the design and uses of mine models.

Prerequisites: Course 1, Mineral Land Surveying, and credit or registration in Course 214, Calculus.

Two hours a week during the second semester of the junior year

(Chedsey.)

3. MINERAL LAND SURVEYING. Field Work and Mapping.

Credit one hour.

This course co-ordinates with Course 1, Mineral Land Surveying, and embraces practice in laying out mining claims on the ground. The students are organized in suitable squads for efficient work in the field. Each squad is required to survey a lode claim, placer claim, mill site, and tunnel site; locate and mark all corners, as required by law in the case of an actual survey; tie the surveys to proper section corners, or other monuments, and obtain all field data required for the calculation of intersections with conflicting claims; perform all office work required in connection with the surveys, including preparation of plate, field notes, and reports required by Land Office Directors and Surveyors General. These surveys are made in the mountains and foothills near Golden.

Prerequisites: Courses 1, Mineral Land Surveying, and 213, Calculus.

One afternoon a week during the first semester of the senior year.

(Wolf, Chedsey.)

4. MINE SURVEYING. Field Work and Mapping.

Credit three hours.

The practice in surface and underground work is given in one of the neighboring mining districts where typical mines are selected which provide a variety of problems common to mine surveying, such as shaft plumbing; adit and drift traversing; and making connections through shafts, tunnels, drifts, raises, winzes, and stopes. The student receives practice and acquires skill in the use of instruments, the taking of measurements, and the securing of important data under the numerous disadvantageous and disagreeable conditions common to underground work. The location of water rights and the surveying of ditches, flumes, pipelines, and aerial tramways are included in this course. The

students are organized in suitable squads for efficient field work and the members of each squad rotate so that each receives practice in a variety of duties. Students are required to make accurate maps of all surveys.

Prerequisites: Courses 2, Mine Surveying, and 214, Calculus.

Four weeks in the summer after the close of the junior year.

(Wolf, Chedsey.)

5. PLACER MINING. Lectures.

Credit three hours.

This course covers the theory and practice involved in the recovery of precious metals from sand and gravel deposits. Among the subjects discussed are: panning, rocking, sluicing; methods of extracting gravel for sluicing; hydraulicing; drift mining; dry placering; dredges and their operation; thawing frozen ground. Typical operations are considered in detail, and special attention is paid to capacity of machinery and operating costs.

Prerequisite: The completed work of the freshman year.

Three hours a week during the first semester of the junior year.

(Chedsey.)

6. FIRST AID AND RESCUE WORK. Lectures.

Credit one hour.

Iu this course the student receives instruction in the rescue and care of injured persons. Among the topics discussed are: the application of temporary dressings to wounds, and splints for broken bones; the treatment of patients suffering from shock; the handling and transportation of the injured; the use of oxygen apparatus in irrespirable atmospheres usually encountered in mine fires and explosions. Students are given opportunity for practice with oxygen helmets in a gaseous mine. The students who complete this course are prepared to pass the examination for the certificate of competency in mine rescue work, granted by the United States Bureau of Mines. Lectures are delivered on tropical diseases and advice is given on the care of health in various climates and under the unfavorable conditions frequently encountered by an engineer.

Prerequisite: The completed work of the freshman year.

One hour a week during the second semester of the junior year.

(Chedsey.)

7. MINE ACOUNTING. Lectures.

Credit one hour.

This course begins with the fundamental principles of bookkeeping. The student is taught how to use the various books,

records, and blanks involved in standard systems of accounting. The course is designed to impart a clear knowledge of double entry bookkeeping. Special attention is given to systems employed in dealing with the accounts of mining corporations, classification of mine, mill and smeltery accounts and the distribution of mining expenditures. The student is taught how to analyze costs, compile an operating statement, take off a trial balance, and prepare a financial report. Each student is required to enter in a set of blank forms the transactions covering a month's operations of a mining company.

Prerequisite: The completed work of the freshman year.

One hour a week during the first semester of the junior year.

(Wolf.)

9. METAL MINING. Lectures.

Credit two hours.

This course begins with a discussion of surface prospecting in various countries, the methods employed and the equipment required; and prospecting for ore, oil, and water by means of churn drilling and core drilling. Next, the methods of opening and developing the different types of mineral deposits are considered and compared. The various methods of excavating earth and rock are discussed and the different tools employed are described. Shaft sinking and tunnel driving are described, and the different systems of stoping are explained. The course includes the consideration of mine timbering; the kinds and properties of timber, and special methods of framing; methods of supporting vein walls with ore and waste filling; hand and machine drills and drilling methods; the different kinds of explosives and their use in blasting; underground haulage; hoisting; surface transportation; wire rope tramways; pumping; ventilation; lighting; and sanitation.

Prerequisite: Course 4, Mine Surveying.

Two hours a week during the first semester of the senior year.

(Wolf.)

10. METAL MINING. Lectures.

Credit two hours.

This course includes the discussion and solution of a variety of practical mining problems which the student is likely to encounter in practice. Knowledge gained in previous mining courses is applied to problems in haulage, hoisting, surface tramming, and pumping. The selection and arrangement of surface and underground equipment is discussed. The various forms of power used in mining operations are discussed and their applications and relative advantages explained. Some of the lectures are illustrated by lantern slides of various mine structures and machinery installations; the subjects so illustrated are dis-

cussed; and the engineering principles considered in their selection and involved in their operation are explained.

Prerequisite: Course 9, Metal Mining.

Two hours a week during the second semester of the senior year.

(Wolf.)

11. MINING LABORATORY.

Credit included in Course 9.

The work in this course is performed in a mine located on Mt. Zion, about three-quarters of a mile from the campus, where the school has built and equipped a mine shop and has driven a 7 by 8-foot adit. The shop is equipped with a forge and tools for blacksmithing, timbering, track-laying, piping and repair work; also drill steel, machine drills, mine cars, and other apparatus used in the underground work. The students work in squads of three or four and perform all of the usual duties involved in the driving of a tunnel, such as track-laying, timbering, drilling by hand and with machine drills, blasting, mucking, and tramming. Under the instruction of a practical miner the students learn to temper and sharpen their own steel to suit the varying conditions of ground and for the different makes of drills. Opportunity is afforded students to do extra work investigating the efficiency and power consumption of different makes of drills and the relative advantages of various brands of high explosives.

Prerequisite: Registration in Course 9, Metal Mining.

A minimum of four half-days during the senior year.

(Knowles.)

12. MINING CORPORATIONS. Lectures. (Elective).

Credit one hour.

This course covers the essentials of corporation law involved in the organization and operation of industrial corporations, particularly those engaged in mining. The various steps in the life of a mining corporation are discussed and analyzed, and the ordinary vicissitudes and the usual methods of facing them are illustrated by typical examples. Methods of recording a corporation's activities in the general books of accounts are explained.

Prerequisite: The completed work of the freshman and sophomore years.

One hour a week during the second semester of the senior year.

(Wolf.)

13. COAL MINING. Lectures.

Credit two hours.

This course begins with a brief review of the geographical and geological distribution of coal, followed by a detailed discussion of the methods of mining coal. Among the subjects covered are: Prospecting coal-bearing areas; stripping and mining surface deposits; methods of opening and developing flat and steep seams; the mining of coal by room and pillar, longwall, and other systems; the methods of breaking coal at the face and the application of the mining methods to thin, thick, flat, rolling and steep beds of anthracite, bituminous, and lignite coal; methods of supporting mine workings; culm flushing; mine gases; safety lamps; ventilation; mine fans and blowers; fresh air requirements of men and animals; the influence of obnoxious gases, earth temperature and barometric pressure on ventilation; spontaneous fires; gas and dust explosions; coal mine inspection.

Prerequisite: Course 4. Mine Surveying.

Two hours a week during the first semester of the senior year.

(Chedsey.)

14. COAL MINING. Lectures.

Credit two hours.

This course includes the study of coal mining machinery and equipment. The following subjects are discussed: Construction and use of punchers, shearing machines, and bar, disc and chain cutters, operated by compressed air and electricity; underground haulage systems; mine drainage systems and pumping installations; types of pit cars and mechanical devices for loading; design, installation and housing of mine fans; arrangement of surface plants and the design of head-frames, tipples, breakers, and washers; bar, revolving and shaking screens; automatic weighing devices; compressed air and electric box-car loaders.

Prerequisite: Course 13, Coal Mining.

Two hours a week during the second semester of the senior year.

(Chedsey.)

15. MINE EXAMINATIONS AND REPORTS. Lectures.

Credit two hours.

This course includes a detailed discussion of the methods of mine sampling. The sampling of fissure veins, placer deposits and coal seams is carefully explained. The measurement of ore bodies and the methods of estimating tonnage are described; and the systems of classifying ore are discussed. The course includes an analytical study of the following subjects:

Factors influencing payability of ore; relation between vein width and stoping width; underground wastes and losses; mining costs; influence of mineralogical composition; losses and deductions involved in metallurgical treatment; milling, transportation and smelting costs; valuation of ore bodies; valuation of surface and underground equipment; appraisement of water rights and other privileges; investigation of geological features and the probabilities and possibilities of extension of ore bodies; calculation of maintenance and depreciation of equipment; and amortization of capital. Methods of recording assays, tabulating calculations and compiling data in comprehensive form, are described. Suggestions are given for the arrangement and presentation of the essential information required in mine reports.

This course is open to seniors only.

Two hours a week during the first semester of the senior year.

(Wolf.)

16. ECONOMICS OF MINING. Lectures.

Credit two hours.

This course begins with a brief review of the fundamental principles of political economy. Then follows an analytical discussion of the underlying factors which influence the operation of the various types of industrial enterprises, with special attention to mining corporations. The different classes of corporate securities are described and the factors which influence the value of mining securities are discussed. Mining costs are classified and analyzed. The application of business principles to mining is explained and emphasized.

This course is open to seniors only.

Two hours a week during the second semester of the senior year.

(Wolf.)

18. MINE MANAGEMENT. Lectures.

Credit two hours.

This course includes a discussion of the following topics: Personal qualities involved in efficient management; value of versatile technical knowledge and experience; general and departmental organization of working forces; application of the principles of efficiency engineering; value of business ability and diplomacy; influence of ideals, enthusiasm, loyalty and *esprit de corps;* systems of labor compensation; classification of labor and efficiency reward; contracts and specifications; leasing systems; marketing mine and mill products; analysis of smeltery contracts; analysis and distribution of mining costs; purchase of supplies; care and maintenance of surface and under-

ground equipment; developing and operating policies; compilation of periodical operating reports.

This course is open to seniors only.

Two hours a week during the second semester of the senior year.

(Wolf.)

19. HYDROELECTRIC POWER DEVELOPMENT. (Postgraduate.)

Credit three hours.

This course involves a detailed study of the arrangement and design of typical hydraulic power plants. The lectures are supplemented by field work and designing in the draughting room. Some of the topics considered are: Reconnaissance; water rights; stream measurements; location and survey of reservoirs; location, design, construction, operation and maintenance of dams, spillways, headgates, flumes, pressure boxes and pipe lines; design, operation and regulation of nozzles; impulse wheels and turbines, location and arrangement of power stations and sub-stations; construction, operation and maintenance of transmission lines.

One hour lecture and six hours field work and draughting during the first semester.

(Wolf.)

20. MINE EQUIPMENT. (Postgraduate.)

Credit three hours.

This course involves a detailed study of the surface and underground equipment of a typical mining property. The lectures are supplemented by field work and draughting. Among the subjects considered are: Hoisting; pumping; haulage; ventilation; air compression and distribution; drilling equipment; shaft houses, blacksmith shops, machine shops, assay offices, storehouses, bunkhouses, and other buildings; tramways; and loading stations.

One hour lecture and six hours field work and draughting during the second semester.

(Wolf.)

METALLURGY.

Professor Frank Weiss Traphagen.
Special Lecturer, Regis Chauvenet.
Instructor Edward Julius Dittus.

27. ASSAYING. Lectures.

Credit one hour.

The theory of assaying is developed in this course. Special attention is given to questions of slag constitution and formation; the relations of minerals; the constitution of ore and the necessary fluxes; the relation of weights; and the development of the assay ton system, with calculations to familiarize the student with the various systems in vogue. The aim of the course is to make the student thoroughly familiar with the principles involved so that his work becomes a scientific procedure rather than a rule of thumb process.

Prerequisite: The completed work of the freshman and sophomore years, excepting Courses 213 and 214, Calculus.

References: Traphagen, **Notes on Assaying.**
Fulton, **Manual of Fire Assaying.**
Lodge, **Assaying.**

One hour a week during the first semester of the junior year, Metallurgical Section.

(Traphagen.)

27a. ASSAYING. Laboratory.

Credit three hours.

Special attention is directed toward making this course as practical as possible. Although the importance of accurate work is at no time overlooked, constant efforts are made to enable the student to handle a large amount of work in a short time. So nearly as possible the student is put under conditions that exist in a smeltery and is made familiar with the systems prevailing in the best conducted laboratories, so that in the end he may be able to take his place at once in such a laboratory without undergoing a breaking-in course after leaving school. The work includes the usual assays called for in the laboratory of mine, mill, or smeltery. The methods include not only those in use so satisfactorily for many years, but also such short cuts as have been introduced by assayers who have several hundred assays to

make daily. The course covers the fusibility of slags of definite composition made up by careful calculation; the fluxing of limestone ores and siliceous ore for practice; the running of lead mixtures of known lead, silica, and base contents to determine the influence of foreign elements and variable gangue; the assays of sulphide and oxide ores of lead; the assay of gold and silver ores of different types by various methods, with a comparison of results; the assay of zinciferous and cupriferous gold and silver ores; the assay of arsenical and antimonial ores; and the crucible and scorification assay of mattes and concentrates.

In the Metallurgical Section additional work is given on the assay of various metallurgical products; of gold, silver, copper, and lead bullions; the various solutions, by-products and products of the cyanide process; of platinum, tin, and mercury; and of miscellaneous ores and products.

Prerequisite: The completed work of the freshman and sophomore years, excepting Courses 213 and 214, Calculus.

References: Traphagen, **Notes on Assaying.**
Fulton, **Manual of Fire Assaying.**
Lodge, **Assaying.**

Eleven hours a week during the first semester of the junior year, Metallurgical Section.

(Traphagen, Dittus.)

28. ASSAYING. Lectures.

Credit one hour.

This course corresponds to Course 27, but is somewhat abridged.

Prerequisite: Same as for Course 27.

References: Same as for Course 27.

One hour a week during the second semester of the junior year, Mining Section.

(Traphagen.)

28a. ASSAYING. Laboratory.

Credit two hours.

This course corresponds to Course 27a, but has not as wide a range.

Prerequisite: Same as for Course 27a.

References: Same as for Course 27a.

Eight hours a week during the second semester of the junior year, Mining Section.

(Traphagen, Dittus.)

29. METALLURGY OF IRON AND STEEL. Lectures.

Credit three hours.

This subject receives first consideration because of its fundamental character and the high state of development of

the industry. In the Mining Section the subject is treated under the following heads: The Manufacture and properties of pig iron; fluxes and fuels, including the manufacture of coke; the blast furnace and accessories; disposal and utilization of furnace gases and slag; chemistry of the blast furnace; manufacture of wrought iron; manufacture and properties of steel; the Bessemer process; utilization and disposal of products; open hearth, cementation, and crucible processes; design and arrangement of plants.

Prerequisites: The completed work of the freshman year; Course 178a, Physical Laboratory; Course 178, General Physics; and Course 156, Quantitative Analysis, which must accompany if not completed.

References: Howe, **Metallurgy of Iron and Steel.**
Stoughton, **Metallurgy of Iron and Steel.**
Campbell, **Manufacture and Properties of Steel.**
Forsyth, **The Blast Furnace and the Manufacture of Pig Iron.**

Three hours a week for the Mining Section during the first semester of the junior year.

(Dittus.)

30. METALLURGY OF LEAD AND ZINC. Lectures.
Credit three hours.

The metallurgy of lead is discussed under the following topics: Ores, their sampling and purchase; fluxes and fuels; roasting; reverberatory and ore hearth practice; the blast furnace, its design and operation; calculation of charges; desilverization by the Pattison, Parks and Betts processes.

The metallurgy of zinc includes: Calcination; roasting; distillation; types of furnaces; manufacture of retorts; and casts.

Prerequisite: Course 29, Metallurgy of Iron and Steel.

References: Collins, **Metallurgy of Lead.**
Hofman, **Metallurgy of Lead.**
Ingalls, **Metallurgy of Zinc.**
Schnabel, **Handbook of Metallurgy.**

Three hours a week for the Mining Section during the second semester of the junior year.

(Dittus.)

31. METALLURGY OF IRON AND STEEL. Lectures.
Credit four hours.

In this course the topics are the same as in Course 29. More expansion is given to the theoretical phases, and to the

calculation of charges in pig iron manufacture. The relative proportions of working parts and their adjustment, the economics of practice, and the difficulties to be encountered in actual operations are given in somewhat greater detail.

Prerequisite: Same as for Course 29.

References: Same as for Course 29.

Four hours a week for the Metallurgical Section during the first semester of the junior year.

(Chauvenet.)

32. METALLURGY OF LEAD AND ZINC. Lectures.

Credit four hours.

In this course the topics are the same as in Course 30, but the subjects are discussed in greater detail in the chemical aspects, in calculation of charges, and in general theory.

Prerequisite: Same as for Course 30.

References: Same as for Course 30.

Four hours a week for the Metallurgical Section during the second semester of the junior year.

(Chauvenet.)

33. ORE DRESSING. Lectures.

Credit four hours.

The following represent the main divisions under which this subject is studied: Jaw and gyratory breakers; rolls; gravity, steam, and pneumatic stamps; special crushing and fine grinding apparatus; apparatus for sizing, including the various types of screens and classifiers; concentrating machines, including jigs, tables, and vanners; dry, magnetic, electrostatic and surface tension concentration; coal washing; and the design of plants.

Prerequisite: The completed work of the freshman and sophomore years.

Four hours a week during the first semester of the senior year.

(Traphagen.)

33a. METALLURGICAL PRACTICE. Laboratory.

Credit one hour.

This course consists of a laboratory study of the principles of ore dressing; the study of the free settling rate; slime settlement; estimation of the quantity and value of suspended slime; screen sizing; and flotation. Laboratory and commercial sized machines receive very careful consideration. The machines are taken apart and a study is made of their construction and operation as pieces of mechanism.

Prerequisites: The completed work of the freshman and sophomore years, with or after Courses 27 or 28

Three hours a week during the first semester of the senior year.

(Traphagen, Dittus.)

35. METALLURGY OF NICKEL, MERCURY, ETC. Lectures. Credit three hours.

This work includes a series of lectures on the properties and metallurgy of mercury, tin, nickel, cobalt and other metals not treated elsewhere, with a general discussion of the principles of treatment and of the best current practice.

Also weekly meetings are held for the consideration of current journal articles on metallurgy, the discussion of thesis work and practice in the abstracting of papers.

In addition, a series of lectures covers the various practices followed in the division of work of plants and the handling of men, together with a study of the systems of keeping accounts and of reporting results.

Prerequisite: The completed work of the freshman and sophomore years. May be taken in conjunction with Course 31.

References: Schnabel, **Handbook of Metallurgy.**

Three hours a week during the first semester of the senior year, Metallurgical Section.

(Traphagen.)

36. METALLURGY OF GOLD, SILVER, AND COPPER. Lectures.

Credit five hours.

This course covers the following subjects: Metallurgy of gold and silver, with special attention to stamp milling, cyanidation and chlorination of gold ores; chloridizing roasting and amalgamation of silver ores; the Russell process and other wet methods for silver; the parting of gold and silver bullion by various commercial methods with special attention to electrolysis and the sulphuric acid test. The various modifications of the cyanide process receive particular attention, especially the treatment of the slime for zinc precipitation; the Moore filter process; the regeneration of the cyanide; the different methods proposed for precipitating the dissolved gold; and the recent application of the cyanide process to silver ores.

The metallurgy of copper includes a critical study of the principles as covered by the best modern practice; the roasting of ores; blast and reverberatory smelting; pyritic smelting; converting of matte; refining of copper; treatment of oxidized ores; and hydrometallurgical methods.

Prerequisites: The completed work of the freshman and sophomore years and Courses 27 or 28, and 32.

May be taken in conjunction with Course 32.

References: Rickard, **Stamp Milling of Gold Ores.**
Parks, **The Cyanide Process.**
Clennell, **Cyanide Handbook.**
Julian and Smart, **The Cyanide Industry.**
Peters, **Modern Copper Smelting.**
Peters, **Principles of Copper Smelting.**

Five hours a week during the second semester of the senior year.

(Traphagen.)

36a. METALLURGICAL PRACTICE. Laboratory.
Credit one hour.

This work includes the testing of gold ores by amalgamation, chlorination and cyanidation; chloridizing roasting and amalgamation of silver ores; roasting and smelting of copper ores and products; tests of complex ores by dry chlorination and other methods; and the laboratory study of such processes as lend themselves to small scale treatment.

This work also covers a study of commercial sized machines and working tests in which the capacity, power, and water consumption are carefully considered. Working tests are run on various types of ore in which careful attention is given to sampling and to checking of results. The machines are first studied individually; their capacities, horse powers, water requirements and other such data are determined; then they are regarded as parts of a system and working tests are carried on in which the function of each machine is critically determined.

The arrangement of the experimental plant is such that various systems of treatment of the same ore may be tried and the results compared.

Prerequisite: Course 33a.

This course is given in groups during the second semester of the senior year.

(Traphagen, Dittus.)

37. METALLURGY. Laboratory.
Credit one hour.

This course is intended to supplement the lecture work of the junior year and includes work with optical and electrical pyrometers; heat value of solid, liquid, and gaseous fuels by the Junker, Parr and Bomb calorimeters; heat treatment of steel; the thermit process; and the desilverization of base bullion.

Prerequisites: The completed work of the freshman and sophomore years and Courses 27 or 28, and 32.

May be taken in conjunction with 32.

References: Howe, **Metallurgical Laboratory Notes.**
Sauveur and Boyleston, **Laboratory Experiments in Metallurgy.**

Three hours a week during the first semester of the senior year, Metallurgical Section.

(Dittus.)

39. ELECTROMETALLURGY. Lectures.

Credit two hours.

This course is divided into two parts. The first part covers the physical phase of the subject, and the second part, the chemical phase.

1. The first part includes the discussion of the phenomena of electrolysis; measurements of the resistance and conductivity of electrolytes; liquid and fused electrolytes; temperature effects; osmosis; the principles underlying the transformation of electrical and chemical energy; electromotive forces and heats of combinations; thermo-electromotive effects; principles of electrical heating; conduction and radiation; efficiency of transformation of electrical energy into heat.

Two hours a week during the first half of the first semester of the senior year, Metallurgical Section.

(Miller.)

2. The second part includes the description and use of electrochemical apparatus; and a discussion of the principles involved in the electrolytic estimation and separation of the more important elements, and the chemical reactions which take place during electrolysis.

Two hours a week during the last half of the first semester of the senior year, Metallurgical Section.

(Test.)

Prerequisite: The completed work of the freshman and sophomore years.

39a. ELECTROMETALLURGY. Laboratory.

Credit one hour.

1. The laboratory experiments in the first part of the course are mainly of a physical nature and exemplify the principles presented in Part 1 of Course 39.

Three hours a week during the first half of the first semester of the senior year, Metallurgical Section.

(Miller.)

2. This part of the course includes practice in the use of electrochemical apparatus and the electrolytic estimation and separation of the more common metals: copper, mercury, silver, zinc, tin, antimony, arsenic, lead, iron, and cadmium.

Three hours a week during the last half of the first semester of the senior year, Metallurgical Section.

(Test.)

Prerequisite: The completed work of the freshman and sophomore years.

41. METALLOGRAPHY. Lectures.
Credit one hour.

This course includes a study of the general methods of thermal analysis of metals and alloys; the apparatus and methods employed in the determination of data; the plotting of cooling curves; the physical mixture, including a consideration of aqueous solutions, fused salts and alloys; freezing point curves and diagrams; the preparation of the specimen for examination; the development of the structure; and the use of the microscope.

Prerequisites: The completed work of the freshman and sophomore years.
Course 30, Metallurgy of Lead and Zinc.

References: Goerens, **An Introduction to Metallurgy.**
Ruer, **Elements of Metallurgy.**
Howe, **Iron, Steel, and Other Alloys.**
Sauveur and Boyleston, **Metallurgy of Iron and Steel.**

One hour a week during the first semester of the senior year, Metallurgical Section.

(Dittus.)

42. METALLOGRAPHY. Laboratory.
Credit one hour.

This course follows the lecture work and includes the study, under the microscope, of steels, gray and white irons, wrought iron and alloy steels as influenced by various heat and mechanical treatments; mattes, speis, base bullion and other metallurgical furnace products. The laboratory work is supplemented by the study of microphotography and thermal analysis.

Prerequisite: Course 41, Metallography.

References: Sauveur and Boyleston, **Metallurgy of Iron and Steel.**
Goerens, **An Introduction to Metallurgy.**

Three hours a week during the second semester of the senior year, Metallurgical Section.

(Dittus.)

43. ADVANCED METALLOGRAPHY. (Postgraduate.) Lectures and Laboratory.

Credit two hours.

This course is an extension of Course 41 and involves a more thorough investigation of the theory of cooling curves and metallic alloys. After this some attention is given to the ternary alloys. The student is then given some individual problems to investigate.

Prerequisite: Course 41, Metallography.

One hour lecture and three hours laboratory, a week during the first semester.

This course is intended primarily for postgraduates, but may be taken by undergraduates with the consent of the instructor.

(Dittus.)

44. ELECTROMETALLURGY. Lectures.

Credit three hours.

This course is divided into two parts.

1. The first part includes the electrolytic treatment of ores and refining of metals, and the parting of gold and silver bullion. On account of the recent trend of metallurgy toward electrical methods of treatment, it is the aim in this course to cover the principles of such treatment and to take up all processes in use or of commercial promise.

(Traphagen.)

2. The second part consists of a course of lectures and recitations on electric furnaces and modern practice in electric smelting. Herein the various types of furnaces and their underlying principles are discussed and comparisons made with ordinary fire methods. Then follows the direct application to the reduction of metals and the manufacture of carbide, carborundum, graphite, and other products.

(Dittus.)

Prerequisite: Course 39, Electrometallurgy.

Three hours a week during the second semester of the senior year.

46. ADVANCED GENERAL METALLURGY. (Postgraduate.) Lectures and Laboratory.

Credit two hours.

This course requires a study of metallurgical processes in the light of a good fundamental knowledge of the subject with the object of gaining a thorough grasp of the underlying principles of metallurgical science. It covers the following subjects: Slag and slag formations suitable to different processes, their chemical properties, formation temperatures, melting points and

other properties; a detailed study of the metallurgy of copper with particular reference to pyritic smelting and converting of copper matte; advanced work in the metallurgy of the precious metals with special attention to ores difficult of treatment and to the use of recovery methods in the cyanide process.

One hour lecture and three hours laboratory a week with assigned reading during the second semester.

This course is intended primarily for postgraduates, but may be taken by undergraduates with the consent of the instructor.

(Traphagen.)

48. METALLURGICAL PLANT DESIGN. (Postgraduate.) (Elective.) Lectures and Drawing.

Credit two hours.

This work is a continuation of the work on power plants, and is intended to cover the design of a complete concentrating mill, a cyanide plant, a chlorination mill, or a smeltery. The work on the part of the student comprises calculations to determine the number and sizes of units to suit the conditions imposed, the selection of machinery and the design of the plant. The student has access to many blue prints from manufacturing companies to facilitate his work.

One hour lecture and three hours drawing a week during the second semester.

This course is intended primarily for postgraduates, but may be taken by undergraduates with the consent of the instructor.

(Traphagen.)

GEOLOGY AND MINERALOGY.

Professor Horace Bushnell Patton.
Instructor Hyrum Schneider.
Instructor Jenner A. Pynch.

In conformity with the general policy of the School, the courses offered in this department are planned with a view to giving the student practical familiarity with those branches likely to be of most service to a mining engineer. A few additional courses are offered to graduate students, but such courses may in certain cases also be open for undergraduates.

51. GENERAL GEOLOGY. Lectures.

The aim of this course is to present the fundamentals of geology in such a way that they can be readily understood by beginners and yet fully enough to give those students who can not pursue advanced courses a fair general knowledge of the subject. The course is a study of physical geology and comprises a discussion of the composition of the earth, including a brief survey of rocks and rock minerals; the agencies internal and external which have in the past produced, and are at present producing, changes on the surface of the earth.

The basis of every science is laboratory work. The principal, in fact the fundamental, geological laboratory is "The Great Outdoors." The region about Golden offers excellent opportunities for students to study geology at first hand. They can see and study for themselves in the field things that are discussed in the class room. A number of field trips are taken each semester. An outline of each trip, with suggestive questions to direct observations, is given to each student. Questions which students are unable to answer for themselves are answered by the instructor in charge of the trip. Written reports of these trips are required. The outlines of the trips with the questions are used as the basis of the reports. Besides the requested field trips, a number of informal tramps are taken. In connection with that part of the course which deals with rocks and rock minerals each student is required to make an individual collection of at least fifteen different kinds of rocks. The rocks must be described giving the general rock class to which each rock belongs, the specific name of each one and the reasons for the classification, all of which must be submitted for correction.

Prerequisite: Entrance requirements.

Text. Blackwelder and Barrows, **Elements of Geology.**

Three hours a week during the first semester of the freshman year.

(Schneider.)

52. GENERAL GEOLOGY. Lectures.

This course is a continuation of Course 51. It is a study of primary and secondary rock structures, with emphasis on the secondary features due to earth movements, such as faults and folds and the value of their proper interpretation to the mining engineer.

Prerequisite: Course 51.

Three hours a week during the second semester of the freshman year.

(Schneider.)

53. CRYSTALLOGRAPHY. Lectures and Laboratory.

This course is treated as an essential part of the general work in mineralogy. Only such portions of the subject are especially emphasized as are of practical value in the determination and proper understanding of minerals. A very thorough drill, however, is given in the more practical portions of the subject. This course is presented through lectures, text book and practical laboratory work; also by individual quizzes. In the laboratory work each student is required to become thoroughly familiar with crystal forms and combinations such as are found on the usual wooden crystal models, and to determine with the aid of a pocket lens and contact goniometer the crystal forms of three hundred crystals.

Prerequisite: Courses 151, 152, General Chemistry.

Text: Patton, **Lecture Notes on Crystallography.**

Lectures two hours, laboratory six hours a week during the first twelve weeks of the sophomore year.

(Patton, Schneider, Pynch.)

54. MINERALOGY. Lectures and Laboratory.

This course begins about the end of the first week in December with a drill for four weeks in the methods of blowpipe analysis, with a view to preparing the student for the practical determination of minerals. This is followed by determinative mineralogy, which continues until the close of the second semester of the sophomore year. About two hundred fifty of the most important mineral species are presented by lecture, in which special emphasis is laid on the recognition of minerals by means of their physical properties and crystal forms. The object constantly kept in mind is not the training that will enable one to

determine any mineral whatever, but rather to recognize at sight such minerals as are likely to be met in connection with mining operations. This is what the average mining engineer is expected to do. With this object in view as thorough a drill as tbe time will allow is given in the actual handling and determining of minerals in the laboratory. In this work each student is expected to handle, to determine and to be questioned and examined on approximately two thousand five hundred individual specimens.

Prerequisite: Course 53.

Text: Butler, **Pocket Handbook of Blowpipe Analysis.**
Butler, **Pocket Handbook of Minerals.**

Lectures two hours, laboratory six hours a week beginning about the first week in December and continuing to the close of the second semester of the sophomore year.

(Patton, Schneider, Pynch.)

55. HISTORICAL GEOLOGY. Lectures.
Credit four hours.

The main object of this course is to give the student a general, but brief, survey of the earth's history. He will be taught how to interpret and associate the major geologic phenomena of the world. Special consideration will be given to the geology of this continent. To this end emphasis will be laid upon the stratigraphical and structural phases of the continents as determined by the epeirogenic and orogenic movements through which they have passed. The economic products, the life system, and the character of the rocks of each time division will receive their proper consideration. The lectures are accompanied by recitations and field trips.

Prerequisites: Courses 51 and 52.

Four hours a week during the first semester of the junior year.

Not required in the Metallurgy group.

(Pynch.)

56. LITHOLOGY. Lectures and Laboratory.
Credit three hours.

This is a lecture course supplemented by laboratory work. The object is to present all the more commonly occurring rocks in such a way as to render their identification at sight reasonably accurate. The methods pursued are purely those applicable to hand specimens without the aid of microscopic sections. The collection of the school is especially rich in those rocks that are usually met in mining operations in Colorado and adjacent

States. Special emphasis, therefore, is laid upon such rocks and upon their various alteration forms.

Prerequisites: The completed work of the freshman year. Course 54.

Text: Kemp, **Handbook of Rocks.**

Lecture two hours, laboratory three hours a week during the second semester of the junior year.

(Patton, Schneider, Pynch.)

57. HISTORICAL GEOLOGY. Lectures.

Credit two hours.

This course is intended to cover the barest essentials of Historical Geology, or, at least, those features of more immediate practical value to the mining and metallurgical student.

Prerequisite: Courses 51 and 52.

Two hours a week during the first semester of the Junior year.

Required in the Metallurgical Group except for those who have taken Course 55. Not required in the Mining Group.

(Schneider.)

58. FIELD GEOLOGY. (Elective.)

Credit three hours.

This course is designed to give a student practice in the various processes involved in preparing a complete geological map. The work covered includes, first, the preparation of a complete topographic map including triangulation and contouring; second, the working out and mapping of the areal geology; third, the study of the economic features, such as ore deposits, that may be found on the territory surveyed. The area selected for study and mapping is usually some mining district in Colorado that has not been mapped and surveyed. The methods used in the preparation of the topographic map are mostly those that admit of rapid work and a degree of accuracy sufficient for most practical purposes.

Prerequisites: The completed work of the freshman and sophomore years.
Courses 55 and 56.

Six or eight weeks during the summer vacation. Open only to a limited number who wish to take a geological thesis for graduation.

(Patton.)

59. FIELD GEOLOGY. (Elective.)

Credit one hour.

This is a briefer course than Course 58 and is intended to give practice in the use of geological instruments and some

practical familiarity with methods of topographic and geologic mapping. It is also intended to train the student in correct geological observation.

Prerequisites: The completed work of the freshman and sophomore years.

This course is intended only for seniors.

Hours to be arranged.

(Patton, Schneider, Pynch.)

60. CERAMIC GEOLOGY. Lectures and Laboratory. (Elective.)

Credit three hours.

This course has to do with the geologic and economic importance of clay deposits. The subject is treated from a geologic point of view. Geologic processes involved in the formation of different types of clay deposits are shown to be responsible for differences in the physical characteristics of the clays. This is brought out in laboratory experiments that are carried on collaterally with lectures. The main object of the course is to familiarize the student with the different types of clays and to give him training in some of the more readily made physical tests that make it possible to judge the value of a clay deposit.

Prerequisites. Courses 51, 52, 53, 54.

Two lectures and one laboratory period during the second semester.

(Pynch.)

61. MICROSCOPIC PETROGRAPHY. Lectures and Laboratory. (Elective.)

Credit three hours.

In this course the study of rocks and rock-forming minerals is carried on with the help of the petrographic microscope. It covers (a) the study of the optical properties of minerals with a view to their identification, and (b) systematic petrography, or the identification of rock type by means of their structures and mineral components.

Prerequisites: The completed work of the freshman and sophomore years.

Course 56.

Lectures and laboratory six hours a week during the first semester of the senior year.

(Patton.)

62. GEOLOGIC AND TOPOGRAPHIC MAPS. (Elective.) Lectures and Laboratory.

Credit two hours.

This course embraces essentially indoor field work and is designed to assist the mining engineer in making a rapid interpretation of the geology of a region through its geologic map.

Prerequisites: Courses 51, 52, and 55.

Six hours a week lecture and laboratory during the second semester of the junior year.

(Schneider.)

63. ECONOMIC GEOLOGY.

Lectures.

Credit three hours.

This course treats of the nature, origin, and occurrence of ore deposits. Special attention is given to the ores which carry the more valuable metals, and to the more important mining camps of the West. The work is carried on principally by lectures with the aid of a text book.

Prerequisites: The completed work of the freshman and sophomore years.

Text: Ries, **Economic Geology.**

Three hours a week during the first semester of the senior year.

(Patton.)

64. ECONOMIC GEOLOGY. Lectures.

Credit three hours.

This is a continuation of Course X, but takes up, in addition to a further discussion of metallic ore deposits, the more important non-metallic products and their sources.

Prerequisite: Course 63.

Text: Ries, **Economic Geology.**

Three hours a week during the second semester of the Senior year.

(Patton.)

65. THE GEOLOGY OF COAL, OIL, AND GAS. Lectures. (Elective.)

Credit three hours.

This course deals with the possible origins, types of occurrence, their geologic setting, and the various reasons for the accumulation of these hydrocarbons, as well as their known geographical distribution over the world. The object of the course is to familiarize the student with all the possible ways in which the substances occur geologically, and an effort will be put forth to prepare him in the recognition and the interpretation of the accompanying field phenomena of these economic deposits.

Prerequisites: Courses 51, 52, 53, 54; also 55 or 57; or may be taken in conjunction with 55 or 57.

Three hours a week during the first semester.

(Pynch.)

CIVIL ENGINEERING.

Assistant Professor Harry Munson Showman.

The aim of this department is to develop the student along such lines in civil engineering as may be required of a mining engineer. This includes some knowledge of plane surveying, structural mechanics, structural design, and hydraulics.

76. THEORY OF PLANE SURVEYING. Lectures.

The purpose of this course is to give preliminary instruction in the principles involved in surveying and by numerous problems to enable the student to acquire speed and accuracy in calculations. Units and general methods of measurement are taken up first and are followed by chaining and transit problems; leveling, stadia surveying, plane-table mapping, and topographic surveying are studied in order. City, land, and railroad surveying are covered briefly. Methods of computation are thoroughly studied. These include closing and adjustment of traverses; omitted measurements; areas; parting off land; earthwork; and the reduction of solar observations for a true meridian.

Prerequisites: Course 205, College Algebra; Courses 207, 208, Plane and Spherical Trigonometry. Course 128, Advanced Projection (Lect. and Drawing).

This course is not intended for students below the sophomore class.

Text: Tracy, **Plane Surveying.**

One hour a week during the second semester of the sophomore year.

(Showman.)

76a. PRACTICE OF PLANE SURVEYING. Lectures and Field Work.

The field work in plane surveying is conducted in the vicinity of Golden and comprises chaining, differential and profile leveling, triangulation, traversing, and numerous exercises with the transit. A topographical map of an extended territory is made by each squad, using the transit and stadia. In addition, several days are spent with the plane table in rapid mapping. At all times the combination of accuracy with economy of time

is emphasized. Lectures are held as often as necessary to give detailed instruction in the adjustment and manipulation of instruments.

Prerequisite: Course 76.

Six weeks following the close of the sophomore year.

(Showman.)

77. MECHANICS OF ENGINEERING. Lectures.
Credit four hours.

This course consists of the theoretical study of mechanisms. and materials; the statics of a material point and of rigid bodies; chains, cords, and cables; stresses and strains; tension, shearing, compression; torsion, flexure; combined torsion and flexure; elastic curves; safe loads, oblique forces; long columns and continuous beams. The student is familiarized with the fundamental ideas of the motions of bodies, the dynamics of a material point, and the extension of this theory to finite bodies. The fundamental differential equations of rectilinear motion are developed and practical applications are found in the case of falling bodies, upward throw, and uniformly and variably accelerated bodies.

Prerequisites: The completed work of the freshman year.
Courses 213, 214, Calculus.
Courses 175, General Physics, and 175a, Physics Laboratory.

Texts: Church, **Mechanics of Engineering.**
Church, **Notes and Examples in Mechanics.**
Cambria Steel.

Four hours a week during the first semester of the junior year.

Required of all students.

(Showman.)

78. MECHANICS OF ENGINEERING. Lectures.
Credit three hours.

This is an extension of Course 77. Virtual velocities introduce the first elements of the principles of work and energy and serve as a basis of discussion in the treatment of the curvilinear motion of a material point which follows. Under this latter head the general equations and principles of curvilinear motion are derived and then applied to simple and cycloidal pendulums, to planetary motion, to a projectile in vacuo, to a body on smooth curved guide, and to absolute and relative velocities. A study is made of rotating bodies, compound pendulums, rudimentary engines, fly-wheels, eccentric pulleys, rolling bodies, parallel rods of locomotives, hoisting in mines, and the like.

Prerequisite: Course 77.

Three hours a week during the second semester of the junior year.

Required of all students.

(Showman.)

80. TESTING LABORATORY.

Credit one hour.

In this course tests are made to determine the strength and stiffness of building materials, such as cast-iron, wrought-iron; steel, plain and reinforced concrete, and wood in tension, compression, shearing, and flexure. Stone and brick are examined for strength, absorption, disintegration, and other qualities which decide their economic values. Experiments to determine the strength of threaded bolts, riveted joints, welds, and nailed joints are included in the course. Tests of cement are made as specified by the American Society for Testing Materials.

Prerequisite: Course 77.

Three hours a week during the second semester of the junior year.

Required of all students in the Mining section.

(Showman.)

82. HYDROSTATICS. Lectures.

Credit one hour.

This course is a short study of the properties of liquids and gases at rest. It comprises hydrostatic pressure, manometers, strength of pipe, pressures in tanks and against walls and dams, immersion and flotation, and the mechanical properties of gases.

Prerequisites: The completed work of the freshman year.
Course 213, Calculus.
Courses 175, General Physics, and 175a, Physics Laboratory.

Text: Church, **Hydraulics.**

Four hours a week after April 10th of the junior year.

Required of all students.

(Showman.)

83. HYDRAULICS. Lectures.

Credit two hours.

The course opens with a brief review of hydrostatics as given in Course 82, takes up the theory and practical application of the properties of fluids in motion, and includes steady flow of liquids through pipes and orifices and over weirs; fluid friction and losses of head; time of emptying vessels; steady flow of water in open channels; impulse and resistance of fluids; pumps and rams; the impulse water motor; overshot, breast, and undershot water-wheels; back water; theorem for flow in a

revolving pipe; turbine and reaction wheels, and the theory of turbine testing.

Prerequisites: The completed work of the freshman and sophomore years. Courses 77, 82.

Text: Church, **Hydraulics.**

Two hours a week during the first semester of the senior year.

Required of all students in the Mining section.

(Showman.)

83a. HYDRAULIC LABORATORY.

Credit one hour.

Measurements are made of the flow over weirs, through orifices and through flumes and ditches. The determination of the approximate law of flow in pipes also forms part of the course. Water-wheels and centrifugal pumps are tested and the efficiency of the hydraulic ram under various conditions is determined.

Prerequisite: This course can be taken only in conjunction with Course 83.

Three hours a week during the first semester of the senior year.

Required of all students in the Mining section.

(Showman.)

85. ENGINEERING CONSTRUCTION. (Elective.) Lectures and Drawing.

Credit three hours.

In this course instruction is given in graphical analysis of the stresses of framed structures of the simpler forms. Comparison is made with the algebraic solutions of the same problems as far as practicable. The design of roof and bridge trusses in steel is then taken up from the theoretical and practical points of view. Steel mill buildings are thoroughly discussed, an analysis of all stresses involved is made, and a complete design is required from each student. In connection therewith the forms, coverings, lighting, ventilation, erection, and similar topics are carefully considered. The design and construction of steel head-frames and ore bins are taken up in detail.

Prerequisites: The completed work of the freshman and sophomore years.
Course 77.

Texts: Ketchum, **The Design of Mine Structures.**
Cambria Steel.
Miscellaneous References.
Lecture Notes.

Lectures and drawing eight hours a week during the first semester of the senior year.

(Showman.)

86. STRUCTURAL DETAILS. (Elective.) Lectures and Drawing.

Credit two hours.

This course is a study of the methods of framing heavy timber. The student is first made familiar with the terms of framing, such as housing, notching, mortise and tenon, dovetailing, lag-screws, dowels and lugs, and from accepted unit stresses, he is led to design joints, splices, deepened beams, trussed beams, and head-frames from wood. A complete design of a combination wood and steel truss is required from each student. A brief study is made of the ordinary timbers used in construction and the best modern methods of protecting them from the action of the elements and wood-destroying insects.

Prerequisites: The completed work of the freshman and sophomore years.
Course 77.

Texts: Jacoby, **Structural Details.**
Cambria Steel.
Miscellaneous references.
Lecture Notes.

Lectures and drawing six hours a week during the second semester of the senior year.

(Showman.)

ELECTRICAL ENGINEERING.

Professor William Jonathan Hazard.
Instructor Ralph Roy Knowles.

101. DIRECT CURRENT MACHINERY. Lectures.
Credit three hours.

This course covers the operating principles of direct current machines, methods of connection, auxiliary apparatus used, field of usefulness of each type, and the calculation.

Prerequisites: Courses 176 and 176a, Physics; and Course 213, Calculus.

Text: Franklin and Esty, **Elements of Electrical Engineering. Direct Currents.**

Three hours a week during the first semester of the junior year.

(Hazard.)

101a. DIRECT CURRENT MACHINERY. Laboratory.
Credit one hour.

In this work the common type of voltmeters, ammeters, and wattmeters are studied and calibrated; switchboards are drawn and used; and the common generators and motors, including the three wire and interpole machines, are studied. Several forms of controllers are wired up and used.

Three hours a week during the first semester of the junior year for the Metallurgical Section.

(Hazard, Knowles.)

101b. DIRECT CURRENT MACHINERY. Laboratory.
Credit two hours.

This course is similar to Course 101a.

Six hours a week during the first semester of the junior year for the Mining Section.

(Hazard, Knowles.)

102. ALTERNATING CURRENT MACHINERY. Lectures.
Credit three hours.

The plan of this course is similar to that of Course 101, but deals with alternating current machinery.

Prerequisite: Course 101.

Text: Franklin and Esty, **Elements of Electrical Engineering. Alternating Currents.**

Four hours a week during twelve weeks of the second semester of the junior year.

(Hazard.)

102a. ALTERNATING CURRENT MACHINERY. Laboratory.

Credit one hour.

A study is first made of the alternating current instruments which are subsequently used in the experimental work. This is followed by a variety of experiments on inductive circuits. Transformers are connected and used in a variety of ways. The starting and running characteristics of induction motors are studied under normal conditions and under some abnormal conditions that are frequent causes of trouble. Synchronizing is done in several ways.

Three hours a week during the second semester of the junior year for the Mining Section.

(Hazard, Knowles.)

102b. ALTERNATING CURRENT MACHINERY. Laboratory.

Credit two hours.

This course is similar to Course 102a.

Six hours a week during the second semester of the junior year for the Metallurgical Section.

(Hazard, Knowles.)

105. SPECIAL APPARATUS AND APPLICATIONS. Lectures. (Elective.)

Credit three hours.

The object of this course is to afford an opportunity for the study of control and protective apparatus, and for a closer study of typical mining installations than is possible in Courses 101 and 102.

Prerequisite: Course 102.

Three hours a week during the first semester of the senior year.

(Hazard.)

106. APPLIED ELECTRICITY. Lectures. (Elective.)

Credit two hours.

This course is an extension of Course 105, and deals with the practical problems of installation and operation of electrical apparatus.

Prerequisite: Course 102.

Two hours a week during the second semester of the senior year.

(Hazard.)

107. SPECIAL APPARATUS AND APPLICATIONS. Laboratory. (Elective.)

Credit one hour.

This course must be taken in conjunction with Course 105. The experiments and tests follow the lecture work.

Prerequisite: Course 102.

Three hours a week during the first semester of the senior year.

(Hazard, Knowles.)

108. APPLIED ELECTRICITY. Laboratory. (Elective.)

Credit one hour.

The work of this course is an extension of Course 107, and is given in conjunction with Course 106.

Prerequisite: Course 102.

Three hours a week during the second semester of the senior year.

(Knowles.)

MECHANICAL ENGINEERING.

Professor Ransom Smith Hawley.
Instructor Claude Sylvester Johnson.
Instructor Ilo Ivan Taylor.

127. DESCRIPTIVE GEOMETRY. Lectures.

This course includes a study of elementary projection; simple problems relating to the point, line, and plane; methods of representation of simple solids; intersecting of solids; and development of surfaces.

Prerequisites: Entrance requirements.

Text: Church and Bartlett, **Descriptive Geometry.**

Two hours a week during the first semester of the freshman year.

(Taylor.)

127a. ENGINEERING DRAWING. Drawing.

The object of this course is to give the student the fundamental principles of drafting according to modern drafting room and shop methods. Considerable time is devoted to freehand lettering, dimensioning, freehand sketching, and detail drawings of simple models. After this follows the application of the problems that are taken up in the lecture work.

Prerequisites: Entrance requirements.

Text: French, **Engineering Drawing.**
Hawley, **Notes.**

Nine hours a week during the first semester of the freshman year.

(Taylor.)

128. ADVANCED PROJECTION. Lectures.

This is a continuation of Course 127 and includes advanced problems in projection; intersections of solids; development of surfaces; working drawings; freehand sketching; and numerous practical applications of these principles to mine surveying and machine design.

Prerequisites: Courses 127 and 127a.

Text: Church and Bartlett, **Descriptive Geometry.**

Two hours a week during the second semester of the freshman year.

(Taylor.)

128a. ADVANCED ENGINEERING DRAWING. Drawing.

This course supplements the lecture course and includes the direct application and graphical solution of the problems that are studied in the lecture room.

Prerequisites: Courses 127 and 127a.

Text: French, **Engineering Drawing.**
Hawley, **Notes.**

Six hours a week during the second semester of the freshman year.

(Taylor.)

129. ELEMENTARY MACHINE DESIGN. Lectures.

This course includes a study of machine elements, the nature of materials entering into machine construction, and elementary calculations involving the strength of materials.

Prerequisites: Courses 128 and 128a.

Text: Marshall, **Elementary Machine Design.**

Two hours a week during the first semester of the sophomore year.

(Johnson.)

129a. ELEMENTARY MACHINE DESIGN. Drawing.

The object of this course is to give the student the principles of orthographic projections when applied to machine drawings executed according to modern drafting and shop practice. Considerable time is devoted to correct methods of lettering and dimensioning of drawings and free-hand sketching. Working drawings, made from models, are submitted of the following: anchor-bolts, shaft-couplings, hangers, pipe-joints, valves, and simple engine parts.

Prerequisites: Courses 128 and 128a.

Text: Marshall, **Elementary Machine Design.**

Three hours a week during the first semester of the sophomore year.

(Johnson.)

130. KINEMATICS OF MACHINERY. Lectures.

This course begins with the theoretical analysis of mechanism and extends to the practical application of these principles to such problems as arise in practice. Special attention is given to the analysis of links, belting, cams, gears, and other contact mechanisms.

Prerequisites: Courses 129 and 129a.

Text: Keown, **Mechanism.**

Two hours a week during the second semester of the sophomore year.

(Johnson.)

130a. KINEMATICS OF MACHINERY. Drawing.

This course supplements and is directly dependent upon the lecture work. The work is taken up from a practical point of view and applies such theory as is consistent with the most approved method of design. Designs and complete working drawings are made of machine parts, gears, cams and various systems and devices used for the transmission of power.

Prerequisites: Courses 129 and 129a.

Text: Keown, **Mechanism.**

Three hours a week during the second semester of the sophomore year.

(Johnson.)

131. STEAM ENGINES AND BOILERS. Lectures.

Credit one hour.

The greater portion of the semester is devoted to steam boiler subjects. After a brief historical treatment of the subject the lectures cover the theory, principles of design, and construction of modern boilers. Numerous practical problems are assigned from time to time so that the student becomes thoroughly familiar with the design and operation of the leading types of boilers.

Prerequisites: Completed work of the freshman year.
Courses 130 and 130a.

Text: Allen and Bursley, **Heat Engines.**

One hour a week during the first semester of the junior year.

(Johnson.)

131a. STEAM ENGINES AND BOILERS. Drawing.

Credit two hours in Mining Group.

Credit one hour in Metallurgy Group.

The drafting room work is devoted principally to the design of power plant apparatus and to such other machinery as is usually found in a mine plant. Boilers, steam engines, hoists, conveying systems, and mill installations are designed, and complete sets of detail working drawings are required in all cases. The value of time is impressed upon the student and all work is done in accordance with the most approved manufacturing methods.

Prerequisites: The completed work of the freshman year.

Text: Allen and Bursley, **Heat Engines.**
Trade Catalogue and Blueprints.

Six hours a week during the first semester of the junior year, in the Mining Group.

Three hours a week in the Metallurgy Group.

(Johnson.)

132. STEAM ENGINES AND BOILERS. Lectures.

Credit two hours.

The lectures of this course embrace principally the subject of steam engines, with auxiliary equipment. The development of the steam engine is first carefully traced out, after which attention is given to thermodynamics and the fundamental principles which underlie the steam engine. Practical problems are assigned the student and great stress is laid upon all matters pertaining to the economical side of the subject. The latter part of the course is devoted to internal combustion engines.

Prerequisites: Courses 131 and 131a.

Text: Allen and Bursley, **Heat Engines.**

Two hours a week during the second semester of the junior year.

(Hawley, Johnson.)

132a. STEAM ENGINES AND BOILERS. Drawing.

Credit one hour.

This course is a continuation of Course 131a and enables the student to undertake and complete some of the more advanced designs of power plant machinery.

Prerequisites: Courses 131 and 131a.

Text: Allen and Bursley, **Heat Engines.**

Catalogues.

Blueprints.

Three hours a week during the second semester of the junior year.

Required in the Mining Section.

(Hawley, Johnson.)

133. AIR COMPRESSORS AND PUMPS. Lectures.

Credit three hours.

This course includes a study of the theory and practice of air compression. Considerable time is given to the study of such principles of thermodynamics as are necessary to a successful understanding of the subject. After this the work comprises a study of single and multiple stage compression; absorption of heat during compression; transmission of power by compressed air; effects of moisture; reheating; valve construction; and types of compressors. The latter part of the course is devoted to a study of pumps and pumping machinery, with special reference to mine service. Steam, electricity, and compressed air as applied to pumping are carefully studied and a complete problem involving calculations of various types of pump for given conditions is carried out.

Prerequisites: Completed work of the freshman and sophomore years.

Course 132.

Text: Peele, **Compressed Air.**

Green, **Pumping Machinery.**

Trade Catalogues.

Three hours a week during the first semester of the senior year.

Required in the Mining Section.

135. MECHANICAL ENGINEERING. Laboratory.

Credit one hour.

It is the purpose of this course to familiarize the student with the theory and principles of the more important scientific apparatus used in engineering investigation. Much stress is laid upon the importance of accurate observations, correct interpretations of data secured through the use of laboratory equipment, and the correct form of engineering reports based upon the results of laboratory experiments. The work includes steam and gas engine indicator practice; the principle and operation of various reducing motions; absorption and transmission dynamometers; determination of the quality of steam; calibration of gages; valve setting; air meters; efficiency tests of steam and gas engines; efficiency and capacity tests of boilers; flue gas analysis; efficiency and capacity tests of air compressors; efficiency and capacity tests of small steam turbines.

Prerequisites: The completed work of the freshman and sophomore years.

Course 132.

Text: Meyers, **Power Plant Testing.**

Three hours laboratory during the first semester of the senior year, Mining Section.

(Hawley.)

134. MINE POWER PLANTS. Lectures.

Credit two hours.

This course includes a detailed study of the units and auxiliaries necessary to a power plant and their various connecting links. Problems affecting the type and location of power plants are taken up. The work is extended to problems which involve the best selection and number of units, location and arrangement, connection with auxiliaries, and the necessary housing for equipment. The items of first cost, operating cost, and depreciation are carefully considered.

Prerequisites: The completed work of the freshman and sophomore years.
Course 133.

Text: Gebhardt, **Power Plant Engineering.**

Two hours a week during the second semester of the senior year.

Required in the Mining Section.

(Hawley.)

134a. DESIGN OF MINE POWER PLANTS. Drawing.

Credit two hours.

The work in this course includes working drawings of some of the power plant equipment taken up and studied in detail in the lecture course. Such problems as the following are assigned: detail of piping systems, including live and exhaust steam, for a certain size plant; foundations for units and auxiliaries; flues and stacks; coal and ash handling machinery.

Prerequisites: Completed work of the freshman and sophomore years.
Course 133.

Text: Gebhardt, **Power Plant Engineering.**
Trade Catalogues.
Blue Prints.

Six hours a week during the second semester of the senior year, Mining Section.

(Hawley.)

136. INTERNAL COMBUSTION ENGINES. Lectures. (Elective.)

Credit two hours.

This course is intended to give the mining engineer a practical working knowledge of the gas engine. The theory and thermodynamics of the gas engine are carefully considered, together with the conditions affecting efficiency and operation. The best types of modern engines together with auxiliary apparatus are taken up and discussed with regard to special features and advantages. Each student is assigned a seminar paper upon some special subject of investigation. At the conclusion of the course these papers are presented before the class. The last two weeks of the course are devoted to practice in operating and running the engines found in the laboratories.

Prerequisites: Completed work of the freshman and sophomore years.
Course 132.

Two hours a week during the second semester of the senior year.

(Johnson.)

137. MINE PLANT DESIGN. Lectures and Drawing. (Postgraduate.)

Credit three hours.

This work is a continuation of the course in power plants and is extended to cover the design of a power plant for a mine. The work in the lecture room begins with an analysis of the problems affecting the location of a typical plant and is extended to an analysis of the various departments of the plant and subsequently to the method of arriving at the power required by each under a particular case. Each student is assigned a problem that includes the design of a power plant for a certain character and size of mine. The work on the part of the student comprises complete calculations to determine the best number and sizes of units to suit the conditions imposed, the selection of machinery, and the design of the plant. The drawings submitted include sufficient detailed and assembled drawings of the surface and underground plants so that the equipment can be installed. Blue prints of most of the equipment that is necessary for this work are kept on hand by the department or are obtained from the various manufacturers.

Prerequisite: Course 134a.

Hours to be arranged.

(Hawley.)

139. MINE PLANT TESTING. (Postgraduate.)

Credit two hours.

This course is arranged with the idea of giving the student an opportunity to obtain data by engineering methods from actually operating plants. The plants from which data are obtained may be those of either coal or precious metal mines, or both. The tests may be conducted upon any one department of the plant or upon the plant as a whole. The work consists for the most part in determining the power and use and efficiency of various makes of machinery for hoisting, pumping, air compression, generating electric light and power, conveying, ventilating, and for general shop purposes. The student takes the necessary apparatus in the field, sets it in place, and conducts the test in such a manner and for such a length of time as is necessary to obtain consistent engineering data. In order to carry on the work successfully the student must be thoroughly familiar with the methods and apparatus used in conducting tests on power plants. The methods used may be summed up briefly as follows: sampling and analyzing coals and gases; sampling and determining quality of steam; indicating reciprocating units; brake horsepower tests; and valve setting and metering steam, air, and electrical energy.

The proximity of the School to plants of mining and metallurgical operations affords special opportunities and facilities for carrying on this work.

One hour lecture and three hours laboratory during one semester.

Prerequisites: Courses 134, 135, and 134a.

Hours to be arranged.

(Hawley.)

CHEMISTRY.

Professor Herman Fleck.
Special Lecturer, Regis Chauvenet.
Assistant Professor Charles Darwin Test.
Assistant Professor John Christian Bailar.

The courses in chemistry are arranged especially for the needs of mining and metallurgical engineers. The demands made upon chemistry by these branches of engineering require a broad knowledge of inorganic chemistry, of the theories which underlie the science, and a close acquaintance with the properties of the elements, their reactions, detection, and separation.

151. GENERAL CHEMISTRY. Lectures.

The course begins with a brief historical sketch of the development of the science of chemistry up to the atomic era. Thereafter history is introduced only as occasion demands. Although the course rests on a structure of inorganic chemistry, the development and application of modern theories and of organic chemistry are taught as the work advances through the non-metallic elements during the first semester. Simultaneously a closer inspection of these elements is offered in the laboratory.

Prerequisites: Entrance requirements.

Text: Holleman, **Inorganic Chemistry.**

Lectures four hours, recitation one hour a week during the first semester of the freshman year.

(Fleck.)

152. GENERAL CHEMISTRY. Lectures.

The second semester proceeds with the metals, which follow in the order of their periodicity, in accordance with the periodic law. Elementary metallurgy and industrial chemistry are introduced as the commercially important metals are considered.

Prerequisites: Entrance requirements.

Text: Holleman, **Inorganic Chemistry.**

Lectures three hours, recitation one hour a week during the second semester of the freshman year.

(Fleck.)

153. QUALITATIVE ANALYSIS. Lectures.

This course treats of the theory of qualitative analysis and of common reactions and tests for metals and acid radicals.

The chemistry of these reactions is carefully drilled and studied. The Law of Mass Action and the Dissociation Theory are dwelt upon in this work.

Prerequisites: Entrance requirements.

Texts: Prescott and Johnson, **Qualitative Analysis.**
School of Mines, **Qualitative Notes.**

One hour a week during the first semester of the freshman year.

(Bailar, Fleck.)

153a. QUALITATIVE ANALYSIS. Laboratory.

The practice of manipulation and the laboratory study of the bases and acids, their reactions, characteristics, and detection are begun.

Prerequisites: Entrance requirements.

Texts: Prescott and Johnson, **Qualitative Analysis.**
School of Mines, **Qualitative Notes.**

Three hours a week during the first semester of the freshman year.

(Bailar, Fleck.)

154. QUALITATIVE ANALYSIS. Lectures.

This course proceeds with the study of the bases and acids, their detection and separation by special methods, and dwells particularly upon correct manipulation, the reactions involved and precautions necessary to obtain correct results. Details are entered into concerning the treatment of compounds, including minerals and mixtures.

Prerequisites: Courses 153 and 153a.

Text: A. A. Noyes, **Qualitative Analysis.**

One hour a week, second semester of the freshman year.

(Bailar, Fleck.)

154a. QUALITATIVE ANALYSIS. Laboratory.

The practice of manipulation and the study of the bases and acids are continued. Their separation and confirmatory tests follow. Analysis of complex mixtures and minerals completes the course.

Prerequisites: Courses 153 and 153a.

Text: A. A. Noyes, **Qualitative Analysis.**

Twelve hours during the second semester of the freshman year.

(Bailar, Fleck.)

155. QUANTITATIVE ANALYSIS. Lectures.
(Gravimetric.)

The work of the first semester begins with a review of the theories of solution, electrolytic dissociation, and mass action

applied to analytical chemistry. The determination and separation of the elements and important radicals are considered in detail. The aim of the course is to study the general principles and methods of separation used in quantitative analysis.

Prerequisites: Courses 151 to 154a, inclusive.

Text: Treadwell-Hall, **Quantitative Analysis.**

One hour per week during the first semester of the sophomore year.

(Test.)

155a. QUANTITATIVE ANALYSIS. Laboratory.
(Gravimetric.)

The work begins with the analysis of simple salts. By this means the practice of manipulation and the observance of necessary precautions are learned. Gradually the analyses of substances of more complex nature are introduced.

Prerequisites: Courses 151 to 154a, inclusive.

Text: Treadwell-Hall, **Quantitative Analysis.**

Six hours per week during the first semester of the sophomore year.

(Test, Bailar.)

156. QUANTITATIVE ANALYSIS. Lectures.
(Volumetric.)

This course consists of a study of volumetric methods of analysis. First, the theory of indicators and methods of acidimetry and alkalimetry are taken up. Later, the methods of the determination of the more important substances are studied Special attention is given to the principles of the methods used in smelter practice.

Prerequisites: Courses 155 and 155a.

Text: Bailar, **Laboratory Notes.**

One hour per week during the second semester of the sophomore year.

(Test.)

156a. QUANTITATIVE ANALYSIS. Laboratory.
(Volumetric.)

This course covers the use of standard solutions and a study of the reactions involved. In due time the methods commonly used in metallurgical industries are introduced. A knowledge of the preparation of standard solutions and their use is acquired by a course in acidimetry and alkalimetry. The preparation of standard solutions and their use in the wet assays of ores and products containing iron, manganese, lead, zinc, copper, and other metals are practiced.

Prerequisites: Courses 155 and 155a.

Text: Bailar, **Laboratory Notes.**

Nine hours a week during the second semester of the sophomore year.

(Test, Bailar.)

157. INDUSTRIAL CHEMISTRY. Lectures.

A broader acquaintance with industrial methods of chemistry, especially in the inorganic field, is essential in the education of the engineer. The course is intended to supply this by illustrated lectures on chemistry applied to the arts and to the apparatus used therein. Among the subjects considered are explosives and the raw materials used, which include sulphur, charcoal, potassium nitrate, nitric acid, sulphuric acid, glycerine, and ammonia.

Prerequisites: Courses 151, 152.

Two hours a week during the first semester of the sophomore year.

(Bailar.)

158. INDUSTRIAL CHEMISTRY. Lectures.

The second semester continues with the following subjects: fuels, clays, refractory materials, boiler compounds, and the alkali industry.

Prerequisites: Course 151 and 152.

Two hours a week during the second semester of the sophomore year.

(Bailar.)

160. METALLURGICAL CHEMISTRY. Lectures.

Credit one hour.

The course undertakes a continuation of the principles involved in metallurgical laboratory practice.

Prerequisites: Courses 156, 156a.

One hour a week during the second semester of the junior year, Metallurgical Section.

(Fleck.)

160a. METALLURGICAL CHEMISTRY. Laboratory.

Credit two hours.

This is a continuation of Course 156a.

Prerequisites: Courses 156, 156a.

Six hours a week during the second semester of the junior year, Metallurgical Section.

(Fleck.)

161. RARE METALS. (Elective.) Lectures.

Credit two hours.

This course undertakes the study of the raw materials, occurrence, localities of occurrence, geology and mineralogy, metallurgy, finished products, uses, and outputs of the rare metals.

Prerequisites: By special permission.

Two hours a week during the first semester of the senior year.

(Fleck.)

162. ELECTROCHEMICAL ANALYSIS. (Elective.) Lectures and Laboratory.

Credit two hours.

The aim of this course is to give the student a practical knowledge of the electrochemical methods of analysis and the more common chemical reactions which take place under the influence of the electric current. That this object may be obtained, the course includes the estimation, by electrochemical means, of about fifteen of the more common metals and afterwards a separation of these metals. The principles are then applied to the analysis of minerals and smelting products. Later, experiments are taken up which illustrate the principles of oxidation and reduction, and a number of substances, the formation of which depends upon these principles, are prepared.

Prerequisites: The completed work of the freshman and sophomore years.

Lectures one hour laboratory three hours a week during the second semester of the senior year.

(Test.)

163. STOICHIOMETRY. Lectures.

Credit one hour.

The course begins with the elements of the subject and includes a review of the first principles of theoretical chemistry, and finally extends to practical, metallurgical calculations. The work consists partly of individual computation by students so as to familiarize them from the beginning with the methods of actual calculation. The work extends into calculations of gas volumes, specific gravity, analytical calculations, and the elements of slag calculations in smelting operations.

Prerequisites: Chemistry 151-154a, inclusive.
Chemistry 157, 158.

One hour a week during the first semester of the junior year, Metallurgical Section.

(Chauvenet.)

164. STOICHIOMETRY. Lectures.

Credit one hour.

This is a continuation of Course 163.

Prerequisite: Course 163.

One hour a week during the second semester of the junior year, Metallurgical Section.

(Chauvenet.)

165. THEORETICAL CHEMISTRY. Lectures.

Credit one hour.

This course includes lectures on the history of chemistry, the development of the science in the nineteenth century, the present aspect of chemical theories, recent advances in synthetical products, and advanced work in stoichiometry.

For seniors only.

One hour a week during the first semester of the senior year, Metallurgical Section.

(Chauvenet.)

166. THEORETICAL CHEMISTRY. Lectures.

Credit one hour.

This is a continuation of Course 165.

For seniors only.

One hour a week during the second semester of the senior year, Metallurgical Section.

(Chauvenet.)

167. PHYSICAL CHEMISTRY. (Elective.) Lectures and Laboratory.

Credit two hours.

A course of laboratory practice in elementary physicochemical measurements and determinations.

Prerequisites: Courses 151 to 156a, inclusive.
Courses 163 and 164.

Lectures one hour, laboratory three hours a week during the first semester of the senior year.

(Fleck, Test.)

PHYSICS.

Professor Louallen Frederick Miller.
Instructor Ralph Roy Knowles.

In arranging the courses of this department the aim is to present thoroughly those physical principles and theories which are fundamental to all engineering subjects. It is also intended to prove the validity of the various physical laws, and to show that they are bound together by exact mathematical relations. Many experiments accompany the lectures in order to demonstrate the practical relation of physics to engineering. Numerous problems are assigned in class which give each student experience in making practical applications of these laws and principles to engineering problems. In the laboratory each student is required to verify quantitatively the laws and principles developed in the lectures.

177. GENERAL PHYSICS. Lectures.

This course consists of lectures, illustrated by experiments, and recitations with assigned problems. The subjects treated are mechanics, including the elements of kinematics, dynamics, and hydrostatics; the properties of matter; heat, including thermometry and expansion, calorimetry, change of state, conduction, radiation, and the elements of thermodynamics; sound, including wave motion in general, production and propagation of sound waves, pitch, reflection, refraction, interference, and resonance.

Prerequisites: Courses 205, College Algebra; 207, Plane Trigonometry; 208, Spherical Trigonometry; 212, Analytic Geometry.

Text: Franklin and MacNutt, **Text Book of Physics.**

Three lectures and two recitations a week during the first semester of the sophomore year.

(Miller.)

177a. PHYSICS. Laboratory.

This course is arranged to accompany Course 177. Its aim is to teach the student the necessity of careful work as well as to acquire skill in physical measurements so that the important physical laws can be quantitatively verified.

Prerequisites: Courses 205, College Algebra; 207, Plane Trigonometry; 208, Spherical Trigonometry; 212, Analytic Geometry.

Course 177 must be taken in conjunction with this course.

Text: Reed and Guthe, **A Manual of Physical Experiments.**

Four hours a week during the first semester of the sophomore year.

(Miller, Knowles.)

178. GENERAL PHYSICS. Lectures.

This course is a continuation of 177. The subjects treated are light, including propagation, reflection, refraction, dispersion, interference, emission, absorption, and polarization; electricity and magnetism, including electrostatics, electro-kinematics, thermo-electricity, magnetic induction, electro-magnetism, electrolysis, the electro-magnetic theory, and electric oscillations; conduction of electricity through gases, and radioactivity.

Prerequisite: Course 177.

Text: Franklin and MacNutt, **Text Book of Physics.**

Three lectures and two recitations a week during the second semester of the sophomore year.

(Miller.)

178a. PHYSICS. Laboratory.

This course is a continuation of 177a.

Prerequisite: Course 177a.

Course 178 must be taken in conjunction with this course.

Text: Reed and Guthe, **A Manual of Physical Experiments.**

Four hours a week throughout the second semester of the sophomore year.

(Miller, Knowles.)

180. RADIOACTIVITY. (Elective.)

Credit two hours.

This course consists of laboratory work accompanied by whatever lectures and collateral reading that is necessary to get a good comprehension of theory before taking the experimental work. There will be opportunity to make practical determinations of ores as well as mineral waters, using both laboratory and field instruments.

The course is intended primarily for post-graduates, and is given to encourage research along these lines. No undergraduates are accepted without special permission.

Prerequisite: The completed work of the freshman and sophomore years.

Six hours a week during the second semester of the senior year.

(Miller.)

182. SPECTROSCOPY. (Elective.)

Credit two hours.

Lectures and collateral reading will be given along with laboratory work. The purpose of this course is to lead up to the determination of metals by spectroscopic methods, more especially the rare metals.

This course is intended primarily for post-graduates, and is given to support research along these lines. No undergraduates are accepted without special permission.

Prerequisite: The completed work of the freshman and sophomore years.

Six hours a week during the second semester of the senior year.

(Miller.)

MATHEMATICS.

Professor Charles Roland Burger.
Assistant Professor George Eulas Foster Sherwood.

The courses in this department are arranged to meet the needs of students in the various branches of engineering. The subjects are treated so as to give the student logical training and power of application. The prescribed courses mark the minimum of mathematical attainments that an engineer ought to possess. The elective courses are closely allied to engineering work and are designed to provide such supplementary study in mathematics as will be useful for further work in physics, electricity, and engineering.

By means of daily quizzes and board work the student is trained into habits of study and application to regularly appointed tasks, and emphasis is given to practical problems such as the student is apt to meet in work in other departments. Habits of accuracy and judgment are formed by persistently checking numerical calculations and examining into the reasonableness of results.

205. COLLEGE ALGEBRA.

This course begins with quadratic equations. Graphical work is early introduced in the belief that the illumination which it affords greatly enlivens the entire presentation of the subject and brings algebra into closer relationship with the other mathematical courses. The following topics are treated: quadratic equations in one or more variables; inequalities; mathematical induction; theory of limits; series; binomial theorem for any exponent; exponential equations; permutations and combinations; partial fractions; and the elementary theory of determinants. Those propositions of the theory of equations which lead to the various methods of approximating the roots of numerical equations are specially emphasized.

Prerequisites: Entrance requirements.

Text: Hawkes, Higher Algebra.

Three times a week during the first semester of the freshman year.

(Burger, Sherwood.)

206. COLLEGE ALGEBRA.

This course is a repetition of Course 205.

Three times a week during the second semester of the freshman year.

Required of all students who have not completed 205.

(Burger.)

207. PLANE TRIGONOMETRY.

The general formulas of plane trigonometry are developed. Inverse functions, identities, and trigonometric equations are carefully considered. The fundamental formulas are memorized. Many problems are solved, special attention being given to such problems as the engineer meets in field and office. By individual supervision every student must solve correctly and check the various cases of the plane-triangle.

Prerequisites: Entrance requirements.

Text: Murray, **Elements of Plane and Spherical Trigonometry.**

Jones, **Tables.**

Two hours a week during the first semester of the freshman year.

(Burger, Sherwood.)

208. SPHERICAL TRIGONOMETRY.

The general formulas of spherical trigonometry are developed. Much practice is given in the solution of the ordinary and the astronomical triangles. Such problems as arise in surveying, practical astronomy, and geodesy are dwelt upon particularly.

Prerequisite: Course 207.

Texts: Murray, **Elements of Plane and Spherical Trigonometry.**

Jones, **Tables.**

One hour a week during the second semester of the freshman year.

(Burger, Sherwood.)

210. PLANE AND SPHERICAL TRIGONOMETRY.

This course is a repetition of Course 207 and includes Course 208.

Required of all students who have not completed courses 207 and 208.

Three hours a week during the second semester of the freshman year.

(Sherwood.)

212. ANALYTIC GEOMETRY.

This course begins with the geometry of the point. The circle and loci in general follow. The conic sections are studied from the equation derived from the general definition. The general equation with term in xy wanting is taken up and from this the special forms relating to the ellipse, hyperbola, and parabola are deduced. A thorough discussion of the most general equation of the second degree follows. Emphasis is given to the graphical study of the trigonometric, logarithmic, exponential, and other transcendental functions.

Solid analytic geometry is developed sufficiently to meet the requirements of the courses in calculus. The point, plane, straight line, cylinders, surfaces of revolution, tangents, normals, are among the topics treated.

Prerequisites: Courses 205 and 207. By special arrangements Course 212 may be taken with 206 or 208.

Text: Bailey and Woods, **Analytic Geometry.**

Four hours a week during the second semester of the freshman year.

(Burger, Sherwood.)

213. CALCULUS.

This course introduces the student to the elements of the calculus. The fundamental principles of continuity, limiting values, and the theory of infinitesimals are established. The differentiation of the fundamental forms, the application to curves and rates and the reversal of rates, maxima and minima, simple problems in quadrature, rectification, and volumes, comprise a large part of the course. A special feature of the course consists in carrying on the differential and integral calculus together. This method of instruction enables the student to grasp the more difficult notions of the subject in their inherent relations and at the same time to apply this knowledge early in the course to the solution of engineering problems.

Prerequisite: Course 212.

Text: Murray, **Differential and Integral Calculus.**

Five hours a week during the first semester of the sophomore year.

(Burger, Sherwood.)

214. CALCULUS.

This course is a continuation of Course 213. The theory of multiple integration is developed and applied extensively to problems involving areas, lengths of arcs, volumes, centers of gravity, moments of inertia, and pressure. Solids of revolution, cylinders, space curves, ruled and quadric surfaces are all given their needed emphasis as applications of the calculus. An ele-

mentary treatment of series, introducing Taylor's theorem, and a chapter on ordinary differential equations together with numerous applications to problems in physics, mechanics, and electricity conclude the course.

The aim throughout is to encourage the student to look upon the calculus as an instrument of power and usefulness rather than one merely of mental development and culture.

Prerequisite: Course 213.

Text: Murray, **Differential and Integral Calculus.**

Five hours a week during the second semester of the sophomore year.

(Burger, Sherwood.)

215. ADVANCED CALCULUS. (Elective.)

Lectures and Recitations.

Credit two hours.

This course is a continuation of Course 214, and presents a variety of topics including: definite integrals; line, surface, and space integrals; Taylor's series and extensions; elliptic integrals; ordinary differential equations; and an elementary treatment of the theory of functions of a complex variable.

Prerequisite: Course 214.

Two hours a week during the first semester.

(Burger.)

216. THEORY OF EQUATIONS. (Elective.)

Lectures and problems.

Credit two hours.

This course is a continuation of Course 205, and is intended for students who have made definite progress in mathematics during the freshman and sophomore years. The course includes the algebraic solution of equations, symmetric functions of the roots, properties and applications of determinants, calculus of imaginaries, and some propositions of the theory of equations which are related to trigonometry. The course is based upon Burnside and Panton's Theory of Equation, and Hobson's Trigonometry.

Prerequisites: Courses 205 and 207.

Two hours a week during the second semester.

(Burger.)

217. ADVANCED ANALYTIC GEOMETRY. (Elective.)

Lectures and Recitations.

Credit, two hours.

This course is a continuation of Course 212, enlarging especially upon the three dimensional features. Among the topics

treated are: reciprocal polars, harmonic and anharmonic properties of conics, methods of projection, geometric methods of infinitesimals, surfaces of the second degree, conicoids, systems of conicoids, plane sections, generating lines, and surfaces in general.

Prerequisite: Course 212.

Two hours a week during the first semester.

(Burger.)

218. ENGINEERING MATHEMATICS. (Elective.)

Lectures and Problems.

Credit two hours.

This course dwells largely upon methods of attacking and solving problems arising in engineering practice. Calculations, curve tracing, and graphical computation are features emphasized in the course. Accuracy, abridged methods, examining into the reasonableness of results, systematic work, are points constantly kept in mind. Problems bearing directly upon the other departments of the School form the basis of the work.

Prerequisite: By special permission.

Two hours a week during the second semester.

(Burger.)

219. DIFFERENTIAL EQUATIONS. Lectures. (Elective.)

Credit two hours.

This course is an introduction to the more elementary portions of the theory of ordinary and partial differential equations. Methods are developed for solving differential equations in terms of the elementary functions. Throughout the course, constant application of the principles studied will be made to problems in geometry and applied mathematics.

Prerequisite: Course 214.

Two hours a week during the first semester.

(Sherwood.)

220. VECTOR ANALYSIS AND QUATERNIONS. Lectures. (Elective.)

Credit two hours.

The subjects treated in this course will include: the addition of vectors, and the multiplication of scalars and vectors; scalar and vector multiplication of two vectors; applications of the principles of the calculus to vectors; vector fields; introduction to the quaternions of Hamilton and Grassmann.

Prerequisite: Course 214.

Two hours a week during the second semester.

(Sherwood.)

221. ASTRONOMY. Lectures and Problems. (Elective.)

Credit two hours.

This course covers a study of the celestial sphere, including the sun, moon, earth, and planets; their motions, forms, dimensions, and physical constitution; the constellations; attraction of the moon; tides; Kepler's laws; problems of gravitation; the measurement of time; problems necessitating familiarity with and use of the Nautical Almanac.

Prerequisite: Course 214.

Two hours a week during the first semester.

(Sherwood.)

222. LEAST SQUARES AND PRACTICAL ASTRONOMY. Lectures and Problems. (Elective.)

Credit two hours.

This course embraces the development of the method of Least Squares; its application to problems in astronomy, physics, chemistry, etc.; such problems of practical astronomy as may be solved by the surveyor, including: (1) latitude by a circumpolar star at culmination; (2) latitude by the altitude of the sun at noon; (3) longitude by transit of the moon; (4) observations for determining the time.

Prerequisite: Course 221.

Two hours a week during the second semester.

(Sherwood.)

ENGLISH.

Professor Regis Chauvenet.

227. ENGLISH.

Credit one hour.

Systematic practice in writing good English is required. The students are trained in the essentials of good usage and, if found deficient, they are required to do extra work designed to meet their needs.

Prerequisite: Entrance requirements.

Two hours a week during the first semester of the freshman year.

(Chauvenet.)

228. ENGLISH.

Credit one hour.

This course aims to develop an intelligent appreciation of the best books. Selected important works are read and studied.

Prerequisite: Course 227.

One hour a week during the second semester of the freshman year.

(Chauvenet.)

229. BUSINESS CORRESPONDENCE.

Credit one hour.

This course is designed to give training in the art of business letter-writing. The aim is not only to acquaint the student with correct forms, but also to develop ability in easy and clear expression.

Prerequisite: Course 227.

One hour a week during the first semester of the sophomore year.

(Chauvenet.)

230. TECHNICAL WRITING.

Credit one hour.

This course begins with a discussion of the special precautions to be observed in writing on technical subjects. Systematic practice is required in describing technical operations and writing about facts and objects involved in scientific work.

Prerequisite: Course 227.

One hour a week during the second semester of the sophomore year.

(Chauvenet.)

MODERN LANGUAGES.

In order to meet an urgent demand for instruction in Spanish for students who expect to follow their vocation in Spanish-American countries, and a similar demand for German and French for students who require a knowledge of these languages in connection with research work or foreign travel, arrangements may be made for the formation of special classes of instruction in modern languages. Upon the application of a sufficient number of students to justify the organization of a class, instruction in Spanish, French or German will be made available as outlined in the following courses. These courses will be conducted by Robert Louis Fleury, Ph.D., Professor of Modern Languages.

231. SPANISH. (Elective.)
Credit three hours.

This is an elementary course covering the essentials of grammar; drill in pronunciation; reading and oral exercises in simple Spanish.

Prerequisite: Entrance requirements.

Three hours a week during the first semester.

For sophomores, juniors, and seniors.

(Fleury.)

232. SPANISH. (Elective.)
Credit two hours.

This course is a continuation of the foregoing and consists of a continuation of grammar and reading, with special attention to the oral study of the language.

Prerequisite: Course 231.

Two hours a week during the second semester.

For sophomores, juniors, and seniors.

(Fleury.)

233. SPANISH. (Elective.)
Credit two hours.

This course includes advanced reading, composition, oral exercise, and practice in conversational Spanish.

Prerequisite: Course 232.

Two hours a week during the first semester.

For juniors and seniors.

(Fleury.)

234. SPANISH. (Elective.)

Credit two hours.

This course is a continuation of the foregoing and consists of practice in conversational Spanish; business and social correspondence; technical literature and scientific terms.

Prerequisite: Course 233.

Two hours a week during the second semester.

For juniors and seniors.

(Fleury.)

235. FRENCH. (Elective.)

Credit two hours.

An elementary course covering the essentials of grammar; drill in pronunciation; reading and oral exercise in simple French.

Prerequisite: Entrance requirements.

Two hours a week during the first semester.

For sophomores, juniors, and seniors.

(Fleury.)

236. FRENCH. (Elective.)

Credit two hours.

This course is a continuation of the foregoing and consists of a continuation of grammar and reading, with special attention to the oral study of the language.

Prerequisite: Course 235.

Two hours a week during the second semester.

For sophomores, juniors, and seniors.

(Fleury.)

237. FRENCH. (Elective.)

Credit two hours.

This course includes advanced reading, composition, oral exercise, and practice in conversational French.

Prerequisite: Course 236.

Two hours a week during the first semester.

For juniors and seniors.

(Fleury.)

238. FRENCH. (Elective.)

Credit two hours.

This course is a continuation of the foregoing and consists of practice in conversational French; business and social correspondence; reading technical literature.

Prerequisite: Course 237.

Two hours a week during the second semester.

For juniors and seniors.

(Fleury.)

239. GERMAN. (Elective.)

Credit two hours.

An elementary course covering the essentials of grammar; drill in pronunciation; reading and oral exercise in simple German.

Prerequisite: Entrance requirements.

Two hours a week, during the first semester.

For sophomores, juniors, and seniors.

(Fleury.)

240. GERMAN. (Elective.)

Credit two hours.

This course is a continuation of the foregoing and consists of a continuation of grammar and reading, with special attention to the oral study of the language.

Prerequisite: Course 239.

Two hours a week during the second semester.

For sophomores, juniors, and seniors.

(Fleury.)

241. GERMAN. (Elective.)

Credit two hours.

This course includes advanced reading, composition, oral exercise, and practice in conversational German.

Prerequisite: Course 240.

Two hours a week during the first semester.

For juniors and seniors.

(Fleury.)

242. GERMAN. (Elective.)

Credit two hours.

This course is a continuation of the foregoing and consists of practice in conversational German; business and social correspondence; reading technical literature.

Prerequisite: Course 241.

Two hours a week during the second semester.

For juniors and seniors.

(Fleury.)

MINING LAW.

Special Lecturer, Frederick S. Titsworth.

251. MINING LAW. Lectures.

Credit one hour.

Beginning with an historical review of the growth of our present laws relating to mining, the course aims to cover every feature of general interest to the practicing mining engineer.

Prerequisite: The completed work of the freshman and sophomore years.

One hour a week during the first semester of the senior year.

Required in the Mining Section.

(Titsworth.)

INSPECTION TRIPS.

The same importance is attached to the inspection trips as to class room and laboratory work. Grades are given on reports submitted and satisfactory results are required.

SENIOR TRIP.

At the conclusion of the senior year an extended trip, lasting about a month, is made to important centers in Colorado, Utah, and Montana for advanced work in geology, metallurgy, mining, and engineering. Detailed work is assigned to each student. The results of his observations and investigations are carefully written and these are criticised by his instructors. Eight professors accompany the class and maintain the same high standard of study that is required at Golden. Private sleeping cars, day coach, and baggage car are chartered for the trip. Everywhere the greatest courtesies are received. Not only are the plants thrown open for inspection, but members of their staffs are detailed as guides. Many students obtain good positions during the trip and form acquaintances that are apt to be of value to them later.

ITINERARY.

COLORADO.

PORTLAND.

Metallurgy.

Colorado Portland Cement Company; crushing and fine grinding of raw material and clinker.

CANON CITY.

Metallurgy.

Empire Zinc Company; wet and magnetic separation of zinc ores and magnetic treatment of Wilfley table middling; experimental plant with magnetizing roaster, magnetic separators, dry and electrostatic separators, and Elmore installation.

United States Smeltery; pigment smelting of complex zinc-lead ore, and the working of the product into a marketable form.

Mining.

Coal Mines; the Canon City coal field is famous as a producer of high-grade domestic coal and is one

COLORADO.

of the few districts in the United States where long-wall mining is practiced.

Geology.

A study is made of the mesozoic sedimentary formations that are upturned in fine hog-backs in a great semicircle around the Canon City basin.

LEADVILLE.

Metallurgy.

Arkansas Valley Plant of the A. S. and R. Company; lead smelting; Ropp, Brown-Horseshoe, Godfrey, and H. and H. roasting; briquetting, and blast furnace treatment of silver-lead ore.

Geology.

The paleozoic series and fault systems as well as the ore bodies are studied underground. The sharply defined moraines, and other glacial phenomena on the surface are also studied.

SHOSHONE.

Engineering.

Central Colorado Power Company, hydro-electric plant. Water from the Grand River is conducted through a tunnel cut into the mountain for approximately two and one-quarter miles, delivered through penstocks to central discharge turbines under a head of 165 feet; capacity of plant, 21,000 h. p.; transmission voltage 100,000.

SHOSHONE AND GLENWOOD SPRINGS.

Geology.

Archaean gneisses and schists, and unconformable above these the paleozoic rocks are exposed in the canon of the Grand River; typical canon erosion and travertine deposits. At Glenwood Springs are the mesozoic rocks.

UTAH.

BINGHAM.

Mining.

This district permits the study of three distinct systems of mining, namely, the overhead stoping, the caving, and the open pit. The extensive properties of the Utah Consolidated Mining Company

UTAH.

and the Utah Copper Mining Company are open to the unrestricted inspection of the class. Further interest in this district comes from the opportunity to study aerial tram systems, difficult railroad engineering, and the operations of single companies under different systems.

Geology.

The carboniferous quartzite and limestone, with intruded igneous masses that have marmorized the limestone at contact; the relationship of the ore bodies to these contact phenomena.

BINGHAM JUNCTION.

Metallurgy.

United States Smelting Company; special roasting devices for lead ores, with neutralization and baghousing of fumes; Huff electrostatic concentration plant for the treatment of zinc-iron middling.

GARFIELD.

Metallurgy.

Utah Copper Company; Arthur and Magna Mills; roll crushing of Bingham ore tabling, and vanning methods of concentration; Garfield tables and Richards-Janney classifiers.

Engineering.

Utah Copper Company; steam power plant; capacity 10,000 boiler h. p.; 500 h. p. Heine boilers equipped with underfeed stokers; forced draft; concrete stacks; large cross compound Allis and Nordberg engines direct connected to alternating current generators; Wheeler surface condensers with independently driven Edwards air pumps.

American Smelting and Refining Company; steam power plant; large horizontal blowing engines; single stage air compressors driven by cross compound Corliss engines; Worthington surface condensers with Blake air and circulating pump; 500 h. p. Sterling boilers equipped with plain grates.

SALT LAKE CITY.

Metallurgy.

General Engineering Company; special devices for screening, classifying, and concentrating ore.

UTAH.

Geology.

Excursion into the Wasatch Range; the great synclinical fold and the Wasatch fault; very recent faults and glacial features; Lake Bonneville terrace formations.

PARK CITY.

Metallurgy.

Daly-Judge, Daly-West, and Silver King Mills; wet concentration of zinc-lead-silver ore; special sampling, crushing, and classifying devices.

Grasseli Mill; dry concentration of table middling; Keedy sizers, and Sutton, Steele and Steele dry tables.

Mining.

Daly-Judge, Daly-West, and Silver King mines; method of handling ore in flat, narrow seams; large square set stopes.

MONTANA.

BUTTE.

Metallurgy.

Butte-Central Mill; concentration and cyanidation of Butte silver ores; economic systems of handling; chilian mills; Deister sand and slime tables; Akins classifiers; tube mills; cone classifiers; Rothwell pulp thickeners; Portland filters; special agitators; zinc shaving precipitation.

Bullwhacker and Butte-Duluth copper plants; sulphuric acid leaching of oxidized surface ores; electrolytic precipitation of copper. These plants differ in arrangement and details of treatment.

Timber-Butte Mill; concentration of zinc ores; special methods of concentration; minerals, separation process.

Butte and Superior Mill; concentration of Black Rock zinc ore by jigging and tabling, with oil flotation of the fine sulphide.

The precipitation plants; recovery of dissolved copper from mine water, leaching and recovery of soluble material from dumps.

Mining.

The mining properties of the Amalgamated, Butte-Duluth, Pilot-Butte, and other copper mining com-

MONTANA.

panies are visited for the purpose of studying modern copper mining methods; driving of working levels in country rock; automatic loading and dumping of ore; rapid hoisting; timbering; square set stoping; mechanical framing of timber; drainage; handling large volumes of acid water; high temperatures of working places; ventilation; surface structures; methods of surveying and mapping; systems of recording geological data.

Geology.

Secondary enrichment of original sulphide ores; the relationship of these ore bodies to the remarkable fault systems of Butte; the study of granite, aplite, porphyry, and rhyolite rocks.

Engineering.

Amalgamated Copper Company; mine plant at the New Leonard; 3,500 h. p. Nordberg hoist; 150-foot steel head frame; two-stage Nordberg air compressors, rope-driven by induction motors; locomotive type of boilers.

Amalgamated Copper Company; mine plants at the Diamond and Bell Mines; large air compressor plant; two stage compressors equipped for either steam or motor drive; 3,000 h. p. Allis hoisting engine; marine type of boilers; high steel head frame with automatic dumping attachments.

ANACONDA.

Metallurgy.

New Reduction Works; track system for the delivery of ores and shipment of products; compressed air traction for yard haulage; concentrating mill of eight one-thousand ton units; bin systems; briqueting plant; largest furnaces in the world; reverberatory furnaces; converter plant; refining furnaces and casting department; arsenic plant, and flue systems; Peck centrifugal concentrator; Laist deslimer; new plant for the treatment of fine material with twenty-deck round tables; roasting-leaching treatment of tailing. So much is to be seen here that more time is spent in this plant than at any other point, and, because of the courtesy of the management, much valuable instruction is possible.

MONTANA.

The Anaconda Copper Mining Company; brick department; the manufacture of clay and silica brick of many shapes and of the highest degree of refractoriness.

Engineering.

New Reduction Works; general power plants; large triple expansion condensing Corliss engine belted to line shaft; two and four-stage air compressors driven by cross compound Corliss engines; rotary blowers of the Connersville and Root types, direct connected to Corliss engines; rotary blowers, rope-driven from induction motors; Stirling boilers equipped with plain grates; rotary converters and transformers for the high tension current brought in from the hydro-electric plants; 2,400-volt d. c. apparatus for the B. A. and P. electrification.

GREAT FALLS.

Metallurgy.

The Anaconda Copper Mining Company; concentration, smelting, and converting of copper ores; large electrolytic refinery for the treatment of anodes from converters. A side trip is sometimes made to this plant from Butte.

SOUTH DAKOTA.

BLACK HILLS.

Mining.

The surface and underground practices of the principal mining companies of this district are studied.

Metallurgy.

Numerous successful amalgamation and cyanidation plants are in operation.

A side trip to the Black Hills district may be taken when returning from the senior trip, or made directly from Denver.

MINING TRIPS.

During the junior and senior years, the students are taken, from time to time, to well known Colorado mining districts for the inspection of actual mining operations. These trips are arranged in such order as to introduce different interesting features and, at the same time, to emphasize definite portions of the class room instruction. Attention is paid to surface plants, underground equipment, mining systems, and to all the regular operations, both above and below ground. Lectures precede these trips to explain their objects, the particular properties to be visited, and the operations to be witnessed. Printed outlines are furnished and each student is required to submit a report, illustrated by his own sketches.

CENTRAL CITY AND IDAHO SPRINGS.

This trip is taken about the middle of the junior year and lasts two days. It includes a study of the mining methods and plants in the narrow veins of the Clear Creek district and the inspection of the long drainage tunnels. The Newhouse tunnel is approximately four miles long and is one of the most famous in the world for mine drainage and transportation.

LEADVILLE AND BRECKENRIDGE.

This trip, taken near the close of the junior year, gives the students an opportunity to study the methods of mining the massive deposits for which Leadville is noted. Underhand and overhand stoping with square sets is seen. At Breckenridge three modern placer dredges are in use, besides hydraulic and steam shovel operations. The lode mines of this district are also visited. During this trip considerable time is spent studying mechanical and electrical engineering features, such as power plants, electric and steam hoisting plants, and high tension electric sub-stations.

CRIPPLE CREEK.

In the Cripple Creek district the students go underground in two or more mines to study mining and transportation methods and make an extended study of the surface plants with complete tests of hoists and steam plants. The Roosevelt drainage tunnel and the methods of handling and treating the enormous low-grade ore dumps are studied.

NORTHERN COAL FIELDS. (First Trip.)

This trip is completed in one day and is intended to give the students an opportunity to observe the method of working coal mines by the room-and-pillar method and the getting of the coal to the surface.

NORTHERN COAL FIELDS. (Second Trip.)

This trip covers detailed studies of ventilation, hoisting, and haulage systems. Different mines are visited. This trip differs from the first in that greater stress is laid upon details.

SOUTHERN COAL FIELDS.

This trip includes a thorough inspection of the mines and surface plants of the Trinidad coal area. Methods of mining on flat and steeply pitching veins and the various arrangements of tipples are studied. Considerable attention is given to coking plants, as one of the largest batteries of bee hive ovens in the world is at Secundo. Coal washing methods and plants are also studied.

Industrial Chemistry Trips.

A trip is made to the plant of the Western Chemical Manufacturing Company, Denver, to study the methods used in the manufacture of sulphuric acid and the chemicals that are usually manufactured in connection with sulphuric acid.

A trip is made to the gas plant of the Denver Gas and Electric Company for a general study of the manufacture of artificial fuels and the treatment of by-products.

A trip is made to the plant of the Golden Pressed and Fire Brick Company to study the methods used in the manufacture of refractories.

Electrical Plant Trips.

Near the end of the junior year trips are made to the generating stations and sub-stations in and about Denver, where nearly all the electrical machinery studied during the year can be seen in commercial use.

METALLURGICAL TRIPS.

GOLDEN.

The pyritic smeltery of the North American Smelter and Mines Company; track and bin system; sampling methods; hot blast stoves; furnaces for agglomerating fine concentrates; blast furnaces; slag and matte handling.

CENTRAL CITY AND BLACK HAWK.

The stamp mills at Central City and Black Hawk are visited for the study of amalgamation, and the Frontenac Mill at Black Hawk is visited for the study of concentration.

IDAHO SPRINGS.

The Jackson, Newton, Hudson, Combination, Argo, and other mills are visited for the study of amalgamation, concentration, and cyanidation of low-grade sulphide ores.

GEORGETOWN.

The Capital and Linn Mills are visited for the study of concentration of lead-zinc ores. The mill of the Western Metals Company, for the dry-chlorination of sulphide ores, is visited for the study of ore treatment by the Malm process, with final recovery of zinc from a fused electrolyte.

DENVER.

The Globe Plants of the American Smelting and Refining Company; sampling; receiving and storage system; bedding of ores; roasting and sintering methods; side-charging blast furnaces; matte and slag separation in reverberatory furnaces; drossing department, and handling of base bullion.

The Sutton, Steele & Steele Experimental Plant. A commercial plant for full scale demonstration of the feasibility of dry separation methods; Ruggles-Cole dryers; elevator and bin systems; screens and screenless sizers; Sutton, Steele & Steele dry tables; and electrostatic separators.

Laboratory of the American Zinc Ore Separating Company; small scale demonstration and testing plant; crushing, sizing, and wet concentration; Huff electrostatic separators; and Plumb's pneumatic jigs.

United States Mint; receiving, melting, sampling, and assaying of gold and silver bullion; electrolytic refining of precious metals; coining of gold and silver.

Western Chemical Manufacturing Company's plant; roasting and magnetic concentration of zinc ores.

The Ore Testing Plant of Henry E. Wood & Company; sampling, crushing, roasting, and concentration of miscellaneous ores; Wood's flotation method; and the Elmore oil-acid-vacuum process.

Greenawalt Hydrometallurgical Experimental Plant for demonstrating the feasibility of leaching and electrolytic precipitation of copper.

Metallurgical Machinery Manufacturing Plants. Ore dressing and metallurgical machinery are studied in process of construction. These machines are usually tested at different plants and opportunities to witness demonstrations are constantly offered our students. Probably no other place in the world offers so many advantages in this respect for, besides standard machines, novelties are constantly being introduced and developed.

COLORADO SPRINGS.

Portland Gold Mining Company's mill for the cyanidation of Cripple Creek ores; bin system; sampling; coarse crushing with breakers and rolls; fine roll crushing; Dunlap screens; Pearce roasting furnaces; classifiers; tube mills; Merrill filter presses for slime; and zinc dust precipitation.

Golden Cycle Mining Company's cyanidation mill; receiving and bin system; crushing in jaw breakers and rolls; sampling; conveyors and storage bins; ball mills; Edwards' roasting furnaces; cooling devices; Chilian mills; blanket tables; amalgamating pans for blanket concentrate.

VICTOR.

Portland Gold Mining Company's Victor Mill; concentration and cyanidation of low-grade Cripple Creek ores; breaking; Lymon's disc pulverizers; Chilian mills; concentration; sand and slime separation; separating solution from sands by washing in classifiers; slime agitators; Portland filters; zinc dust precipitation.

Independence Mill; treatment of old dump material and low-grade ore; gyratory breaking in two stages; roll crushing; pulverizing in solution with Chilian mills; classification with Ovoca classifiers; sand leaching and draining; slime agitation with bromo-cyanide; filtration with Butters filters; zinc shaving precipitation.

Ajax Gold Mining Company's mill; direct treatment of low-grade Cripple Creek ore without roasting or concentration; fine grinding in tube mills; agitation of pulp with electric current passing.

PUEBLO.

Colorado Fuel and Iron Company's Minnequa Plant; the largest iron and steel works in the West; receiving system; stock piles and bins; electric charging cars; modern blast furnace construction and practice; blowing engines and hot blast stoves; dust catchers and washers; gas-fired boilers; Bessemer and open hearth practice; complete plants for working up products; blooming mills; plate mill; rail mill; wire and rod mill; nail and spike mill; galvanizing department; and all details of practice at a complete plant. A regular junior trip.

American Smelting and Refining Company's Pueblo Plant; silver-lead smelting; top-charged blast furnaces; matte and slag separation in forehearths; briquetting department; Dwight-Lloyd and Huntington-Heberlein sintering systems; extensive bedding system; drossing department; cupellation furnaces for production of high-grade assay litharge.

United States Zinc Company's zinc smeltery; hand-rabbled and Hegeler roasting furnaces; manufacture of retorts; charging and distillation.

OURAY.

The mills of Camp Bird, Limited, and many other mills and metallurgical plants in the vicinity of Ouray, may be visited for the study of stamp-milling, amalgamation, concentration and cyanidation.

TELLURIDE.

The famous milling plants of the Smuggler-Union Mining Company, the Tomboy Gold Mines Company, Ltd., and the Liberty Bell Gold Mining Company, are located near Telluride. In these plants may be studied the latest practices in stamp-milling, amalgamation, concentration, and cyanidation of gold ores. Within a radius of fifteen miles of Telluride are located the reservoirs, waterways, pipe lines, power plants and power transmission lines of the Colorado Department of the Telluride Power Company, the pioneer company in high tension power transmission.

SILVERTON.

The well known milling plants of the Silver Lake, Gold King, Gold Prince, Grand Mogul, Old Hundred, Sunnyside

and Hercules gold mining companies, may be visited from Silverton, for the study of stamp-milling, concentration and cyanidation.

DURANGO.

The American Smelting and Refining Company's Durango Smeltery.

SALIDA.

The Ohio and Colorado Smelting Company's lead smelting plant.

LEADVILLE.

The American Smelting and Refining Company's Arkansas Valley Smeltery.

BOULDER COUNTY.

This county is the great producer of tungsten concentrates and there are many well designed mills built for the treatment of tungsten ores. The county also produces a variety of gold ores, for the treatment of which numerous mills have been erected.

GENERAL INFORMATION.

EXPENSES.

TUITION.

The Statutes of Colorado provide as follows:

"The said School of Mines shall be open and free for the instruction to all **bona fide** residents of this State, without regard to sex or color, and, with the consent of the Board, students from other States and territories may receive education thereat upon such terms and at such rates of tuition as the Board may prescribe."

The tuition for non-residents is one hundred fifty dollars a year, payable in two installments—seventy-five dollars at the beginning of each semester.

FEES.

Fees are charged to cover depreciation, necessary repairs, maintenance, and renewal of permanent apparatus, materials destroyed and not returnable, power, gas, and other similar items.

The athletic fee, although collected by the School, is turned over to the Treasurer of the Athletic Association and is expended only for athletic purposes.

No part of a fee is returnable.

GENERAL FEES.

Matriculation	$ 5.00
Athletic (each semester)	5.00
Thesis	2.00
Graduation	5.00

LABORATORY.

Chemical Laboratory, Courses 153a, 154a, 155a, 156a, and 160a (each course)	7.00
*Electrochemical Analysis, Course 162	2.00
Physical Laboratory, Courses 177a and 178a (each course)	4.00
Surveying, Course 76a	5.00
Crystallography, Course 53	4.00
Mineralogy, Course 54	14.00
Assaying, Courses 27a and 28a	10.00

* Elective Courses.

Testing Laboratory, Course 80	$ 2.00
*Radioactivity Laboratory, Course 180	4.00
Hydraulics Laboratory, Course 83a	1.00
Lithology, Course 56	3.00
Mine Surveying, Course 4	3.00
Mineral Land Surveying, Course 3	3.00
*Petrography, Course 61	5.00
Mining Laboratory, Course 11	5.00
Ore Dressing Laboratory (each semester) Courses 33a and 36a	5.00
Electrometallurgical Laboratory, Course 39a	5.00
Steam Laboratory, Course 135	5.00
*Summer Field Geology, Course 58	5.00
Electrical Laboratory (each semester), Courses 101a, 101b, 102a, 102b	5.00
*Ceramic Laboratory, Course 60	6.00
*Mine Rescue, Helmet Work	5.00
Drawing (each course)	.25

DEPOSITS.

Deposits are required to cover the cost of apparatus and supplies issued to individual students and returnable if in good condition.

Chemical Laboratory, Courses 153a, 154a, 155a, 156a, and 160a (each course)	$10.00
Assaying, Courses 27a and 28a	25.00
Electrometallurgical Laboratory, Course 39a	5.00
Locker	1.00
Drawing	2.50

POST GRADUATE ELECTIVE COURSES.

Hydroelectric Power Development, Course 19	$ 3.00
Radioactivity, Course 180	4.00
Spectroscopy, Course 182	4.00
Physical Chemistry, Course 167	2.00

SHORT COURSE IN COAL MINING.

This course, of two months duration, is given annually for the benefit of coal mine employes. Its object, aside from general educational purpose, is to prepare candidates for positions in coal mines to pass the required State examinations under the laws regulating coal mining.

The course opens April 1, 1914, and ends Wednesday, May 27, 1914.

---

* Elective Courses.

The dates of successive terms will be announced by circular from year to year.

The following is a brief epitome of the subjects taught:

1. MINING. Opening new areas. Use of explosives. Haulage and loading. Drainage and pumping. Power. Surface equipment. Air requirements. Dust explosions. Ventilation. Mining methods. Elementary surveying. Mining machines.

2. CHEMISTRY. Elementary definitions. Composition of air, water, and mine gases. Combustion, and chemical principles involved in gas explosions. Theory of the safety lamp. Composition of coals. Practical laboratory work on coal and gas analysis.

3. MATHEMATICS. Weights and measures. Arithmetic, from ground rules and decimals to ratio and proportion. Simple physical problems, elementary algebra and use of logarithms. How to use the formulae commonly required in coal mining.

4. MECHANICS AND DRAWING. A short course in mechanics, drawing, mapping, and the use of instruments.

5. GEOLOGY. Elements of Geology, with special reference to coal deposits, with laboratory work on rocks, supplemented by short trips in the vicinity of Golden.

No fees for instruction. In the laboratory, material actually consumed will be charged for, also two or three text books will be required, total expense not to exceed five dollars.

TEXT BOOKS AND STUDENTS' SUPPLIES.

The cost of text books and students' supplies necessarily varies, but the following are fair estimates, probably maxima:

Freshman year:	Text books	$20.00
	Drawing supplies	20.00
Sophomore year:	Text books	20.00
Junior year:	Text books	25.00
Senior year:	Text books	25.00

BOARD AND LODGING.

The School has no dormitory. Board can be obtained in private families for five to six dollars a week. Students' clubs furnish board for about twenty dollars a month. Rooms can be obtained for eight dollars to twelve dollars a month.

OTHER EXPENSES.

There are other expenses incidental to the mining, metallurgical, engineering, chemical, and geological trips, which vary so widely that they can not be estimated. The preparation of the senior thesis may also involve expenses which vary with the nature and treatment of the subject.

Students leaving in mid-term, except on account of severe or protracted sickness, are not entitled to the return of fees or tuition. **All charges of the College are payable strictly in advance at the beginning of each semester.** No student is allowed to be graduated while indebted to the School. The Trustees reserve the right to make incidental changes in fees and deposits without printed notice, as new and unforeseen emergencies may arise.

Students who desire to earn money to defray their College expenses are advised to limit their work to the summer vacation. The course of study is too exacting to allow much time during the college year for outside work.

The total expenses of the college year, including room and board but exclusive of tuition and the expenses of the senior trip, need not exceed five hundred dollars, and may be reduced considerably by strict economy.

SUMMER SCHOOL.

For the benefit of matriculated students who desire to make up deficiencies, or who wish to do advanced work, and for the benefit of prospective students, a Summer School has been established. It begins about the middle of July and continues for six weeks. Special circulars describing the courses offered will be sent, on application to the President.

ENGINEER COMPANY

National Guard of Colorado.

A company of engineers of the National Guard of Colorado is stationed in Golden. The company has its headquarters at the new Armory within a block of the campus. The officers of the company are:

Joseph C. Taylor .....Captain
Herbert T. Quick .....First Lieutenant.
Robert A. Thurstin .....Second Lieutenant

On account of the value of the technical training received, the school allows a half hour credit for each full year of enlistment.

THE QUARTERLY.

Four times a year, in January, April, July, and October, the School issues the Quarterly. The various numbers include the Catalog, the Book of Views, Commencement addresses, and articles of a mining or of a metallurgical nature.

METHOD OF GRADING.

The following system of grading is used:

A—Excellent.
B—Good.
C—Fair.
D—Conditioned.
E—Failed or Subject Dropped.

A, B, and C are passing grades.

D (Conditioned) means that the student is not passed. The deficiency may be removed by passing a re-examination or by otherwise completing the work. Unless a condition is removed before the beginning of the next school year the D becomes an E.

E (Failed or Subject Dropped) means that the subject must be taken again, and that no subject depending upon this one may be taken until the E is removed. In removing an E the student must take the subject again either at a regular period or under conditions approved in writing and in advance by the head of the department.

A student who at any time has conditions amounting to a total of twelve hours of work may not remove any of these conditions by re-examination, but must in each case take the subject again. In deciding whether a student has a total of twelve hours of conditions all Ds and Es received during the current school year will be counted; that is, in the first semester only first semester conditions will be counted, but in the second semester there will be added to the conditions received during that semester all unremoved conditions received during the first semester.

Three hours of laboratory or of drawing are regarded as the equivalent of one hour.

In case a student fails to complete his work in any subject the instructor may, at his discretion, report to the office not a D but an "Incomplete", which shall be designated by the letters "Inc." This is not regarded as a condition, but it becomes an E at the beginning of the next school year unless previously removed, or unless an extension of time is given in writing by the instructor in charge.

In case a student leaves school with one or more conditions and returns after an absence of a year or more, the term "next school year" will be interpreted to mean the next school year of his attendance; but in case he leaves at the close of the first semester he may return at a similar period a year or more later, subject to the conditions under which he left, as though there had been no break in his attendance, except in case of a changed curriculum.

No student may take any junior subject until he has re-

ceived credit in all freshman subjects; and no student may take any senior subject until he has received credit in all freshman and sophomore subjects. In the case of students admitted to advanced standing, this rule is suspended during the first year of their attendance.

THE LIBRARY.

The college library occupies one-half of the second floor of Guggenheim Hall. The room is well lighted and ventilated and has a seating capacity for one hundred twenty readers. The library contains about twelve thousand volumes and several hundred pamphlets, principally of a technical nature, and is being increased in subjects corresponding to instruction given in the school. Direct access to the shelves is permitted to all students in order that they may obtain the benefit of examining the books themselves. Books which are not needed for special reference work are loaned for home use for a period of two weeks. The card catalogue includes entries under author, title, and subject, arranged on the dictionary plan. The classification is an adaptation of the Dewey decimal system to the needs of a technical library.

The library subscribes to the publications of the leading scientific societies of the world and to the chief literary and scientific periodicals. It is especially rich in files of engineering journals, the material in which is available for ready reference through excellent periodical indexes received monthly. The library is a depository for the documents of the United States Geological Survey and has an unusually complete collection of the publications issued by state geological surveys and mining bureaus both in this country and abroad. A collection of mine reports has recently been indexed and made available for reference.

During the academic year the library is open from 8 to 12 a. m., from 1 to 5, and from 7 to 9:30 p. m., except on Saturdays and holidays. On Saturdays the library is closed in the afternoon.

Y. M. C. A.

The Colorado School of Mines Young Men's Christian Association is one of 624 Student Associations in the colleges, universities, normal; professional and preparatory schools of the United States and Canada, March 31, 1913. Four hundred and seventy-seven of these institutions reported 175,837 young men enrolled as students on the above date, and of this number 60,919 were members of the College Young Men's Christian Associations.

The Y. M. C. A. of the Colorado School of Mines exists for the purpose of serving the men of the School in every possible

way. When called upon to do so, the Association assists men in securing suitable boarding and rooming accommodations, and when possible, in securing employment to help them earn their expenses through school. Weekly Bible Study Classes and religious meetings are conducted during the greater part of the year. The "Mines Hand Book" is published annually and distributed free of charge to students, faculty, alumni, and prospective students. It contains useful information concerning the School, Golden, and vicinity. A copy of this book will be sent, on application to the General Secretary of the Association.

An Advisory Board, consisting of one alumnus, one local minister, one local business man, and two faculty members supervises the work of the Association. The present board members are: Professor Horace B. Patton, Professor Charles R. Burger, Rev. George E. Keithley, Mr. George W. Parfet, and Mr. Clare L. Colburn.

The officers for 1913-1914 are: President, F. L. Pittman, '14; Vice-President, E. F. Baker, '14; Secretary, C. E. Wuensch. '14; Treasurer, W. L. Beck, '14; Assistant Treasurer, F. E. Briber, '16; General Secretary, J. C. Stephens, University of Wisconsin, '11.

Y. M. C. A. SPEAKERS, 1913.

C. C. HOPKIRK, M. D. ..... Chicago, Illinois
Sex Hygiene.

REV. C. B. STEELE ..... Golden, Colorado
A Heroic Life.

HAROLD W. MOORE ..... Denver, Colorado
A Business Man's Belief.

BISHOP FRANCIS J. McCONNELL ..... Denver, Colorado
An Appeal to the Supreme Court.

REV. E. N. ORR ..... Denver, Colorado
The Forgotten Elements in Christianity.

REV. G. E. KEITHLEY ..... Golden, Colorado
Manliness, True and False.

REV. FRANK T. BAYLEY ..... Denver, Colorado
The Place of Religion.

REV. H. F. ROLL ..... Denver, Colorado
A Basis for Faith.

REV. C. B. WILCOX ..... Denver, Colorado
The Working of a Man.

REV. O. W. FIFER ..... Denver, Colorado
Two Men of Leadership.

REV. DAVID H. FOUSE ..... Denver, Colorado
A Gospel for a Strenuous Age.

REV. JOSHUA GRAVETT ..... Denver, Colorado
Religious Certainty.

THE INTEGRAL CLUB.

The Club Room is in the Gymnasium Building and is furnished in the ordinary style of a gentleman's club. The purpose of the Club is to foster good comradeship among the students. It is under the direct control and management of a student committee:

Neil M. McNeill, '14, Chairman.
Alpheus B. Beall Jr., '15.
Howard E. Hornickel, '16.

PRIZES.

At the commencement exercises, May 23, 1913, the following prizes were awarded:

The Brunton Transit, presented by David W. Brunton, of Denver, to Lawrence G. Trueheart and Fidel Martinez.

Thesis: A preliminary report on "La Mina Soledad."

The Stoiber Prize given each year by Mrs. Stoiber-Rood, was divided.

One hundred dollars was given to Richard A. Leahy.

Thesis: "The Settling Rates of Slime."

Fifty dollars each was given to Charles E. Prior Jr., Irvin R. Solomon, and Howard C. Smith.

Thesis: "The Production of Ferro-Vanadium Alloys in the Electric Furnace."

SCIENTIFIC SOCIETY.

The Scientific Society has for its object the presentation and discussion of technical and engineering subjects. From time to time, lectures are delivered before the Society by leading authorities on various topics of interest to its members and friends. The selection of these speakers is placed in the hands of an executive committee chosen from the senior and junior classes. All lectures are held in Simon Guggenheim Hall, on such nights as are most convenient for the majority of the students. The proceedings of the Society are printed in "The Colorado School of Mines Magazine." The alumni, faculty, senior, and junior classes of the institution constitute the active members of the organization; the sophomores and freshmen are associates.

The officers for the year 1913-14 are:

Frederick S. McNicholas, '14, President.
John R. Shanley Jr., '15, Vice-President.
Ernest R. Crutcher, '14, Secretary.
L. Adair Stewart, '15, Treasurer.

SOCIAL LIFE.

Social life in the College is fostered by a committee of students which consists of the presidents and two other members from each of the four undergraduate classes of the School. The president of the senior class is chairman of this committee. A reception is given at intervals. The committee for 1913-14 is:

Russell P. Luke, '14, Chairman; Lionel Brooke, '14; Keith Roberts, '14; B. C. Essig, '15; L. L. White, '15; R. P. Oliveros, '15; C. B. Gauthier, '16; H. M. Lavender, '16; J. M. Lliteras. '16; W. H. Williams, '17; G. R. Durkee, '17; J. C. Smith, '17.

DEPARTMENT OF ATHLETICS AND PHYSICAL TRAINING.

By virtue of the athletic fee required, all students entering the School of Mines become members of the Athletic Association.

The Association is supported by the student fees, gate receipts, and by contributions from the alumni and other friends of the School.

The affairs of the Association are managed by a Board of Control, which consists of eleven members: the Athletic Director, Mr. Erle O. Kistler, Chairman; the captains of the football, baseball, basketball, and track teams; and the presidents of the junior and senior classes.

The Athletic Association maintains an office in the Gymnasium Building, under the supervision of the athletic director.

Opportunity is offered for systematic physical development of the student under the instruction of Capt. Will C. Bryan, trainer, who will conduct regular classes.

ALUMNI ASSOCIATION.

The aim of the Alumni Association is to promote acquaintance and friendship among the graduates, to encourage them to aid each other, and to make an organized effort to elevate and uphold the reputation and standard of their Alma Mater. To carry out these ideas the Association, under the management of an Assistant Secretary and Treasurer, publishes monthly "The Colorado School of Mines Magazine" and conducts an employment bureau, or Capability Exchange, for the benefit of the members.

All graduates are earnestly requested to join the Association, and to keep the assistant secretary and treasurer advised of their addresses and occupations.

The officers of the Association are:

William B. Milliken, '93, President.
Orvil R. Whitaker, '98, Vice-President.
Marshall D. Draper, '97, Secretary.
W. O. Chamberlin, '05, Treasurer.

Executive Committee—Frederick S. Titsworth, '95; George W. Schneider, '94; George A. Kennedy, '95.

Orville Harrington, '98, Assistant Secretary and Treasurer; Editor and Manager of the Colorado School of Mines Magazine; Manager of the Capability Exchange.

The Association holds its annual meeting and banquet on the day following the commencement exercises, unless otherwise provided for by the Executive Committee.. All graduates are eligible to membership and are invited to the annual meeting and to the banquet.

A regular monthly luncheon is held in Denver on the third Saturday of each month at 12:30. All graduates of the School and the members of the junior and senior classes are invited to attend these informal luncheons, which are held to promote acquaintance and fellowship among Mines men. Members are privileged to bring guests.

ENROLLMENT OF STUDENTS.

POSTGRADUATES.

Barney, Henry A.....Dayton, Ohio
C. E. Ohio Northern University.

Carstens, Carl E.....Ackley, Iowa
A. B. Lake Forest College.

Cheney, George M.....Williamstown, Mass.
A. B. Williams College.

Gow, Thomas T.....Tunchow, Shantung, China
A. B. Shantung Union College.

Graham, Allan H.....Ottawa, Ohio
B. S. Ohio Wesleyan University.

Hayden, Wallace H.....Batavia, N. Y.
A. B. Bowdoin College.

Landau, Henry.....Standerton, Transvaal, S. A.
A. B. Cambridge University, England.

Moses, Percival S.....Savannah, Ga.
Ph. B. Sheffield Scientific School.
Yale University.

Thurstin, Robert A.....Bowling Green, Ohio
B. S. Kenyon College.

Watson, Samuel E.....Clarksville, Texas
E. M. Colorado School of Mines.

Wilkinson, Mearle W.....Denver, Colo.
E. M. Colorado School of Mines.

CLASS OF 1914.

SENIOR CLASS.

President, Russell P. Luke.
Vice-President, Adolph Bregman.
Secretary, Thomas W. Callahan.
Treasurer, Earle A. Strong.

Baker, Erwin F.....Denver, Colo.
Barney, Henry A.....Dayton, Ohio
C. E. Ohio Northern University.
Beck, W. Lloyd .....Denver, Colo.
Bowhay, Arnold A., Jr.....Denver, Colo.
Brandow, Glen A.....Canandaigua, N. Y.
Bregman, Adolph .....New York, N. Y.
Brooke, Lionel .....Gaffs, Calif.
Brousseau, Andre R.....New Orleans, La.
Brugger, Melvin ..... Columbus, Neb.
Cadot, John J.....Columbus, Ohio
Callahan, Thomas W.....Golden, Colo.
Carper, Armistead F.....Denver, Colo.
Chen, Yefah F.....Shanghai, China
Cheng, Dah-Chun .....Kiang-yin, China
Clark, Louis F.....Grand Rapids, Mich.
Craig, Allan E.....Denver, Colo.
Crampton, T. H. M.....Golden, Colo.
Crutcher, Ernest R.....Salida, Colo.
Espinosa, Miguel E.....Mexico City, Mex.
Fischer, Oscar A.....Chicago, Ill.
Foo, Shu .....Chungking, China
Foote, Frederick W.....Boulder, Colo.
Gow, Thomas T.....Tunchow, Shantung, China
A. B. Chuntung Union College.
Grant, Bertram .....Philadelphia, Pa.
Graybeal, Edward V.....De Beque, Colo.
Grigsby, Gail G.....Denver, Colo.
Griswold, George G., Jr.....Perth Amboy, N. J.
Gross, Le Roy M.....New York, N. Y.
Hammen, Charles W.....Chicago, Ill.
Harper, Robert R.....Des Moines, Iowa
Hayden, Wallace H.....Batavia, N. Y.
A. B. Bowdoin College.
Hutton, Meritt .....Denver, Colo.
Johnson, John B.....Wheeling, W. Va.
Klatt, Carl L.....Golden, Colo.
Koelker, Karl L.....Toledo, Ohio
Krohn, Arthur .....Chicago, Ill.
Krumm, Samuel Z..... Columbus, Ohio
Lee, Ping .....Wusih, China
Litchfield, Rufus E.....Fitchburg, Mass.
Luke, Russell P.....Wilkesbarre, Pa.

McNeill, Neil M.....Plum Bush, Colo.
McNicholas, Frederick S.....Durango, Colo.
Moses, Percival S.....Savannah, Ga.
Ph. B. Sheffield Scientific School.
Yale University.
Pearce, James W.....Denver, Colo.
Pittman, Frank L.....Tacoma, Wash.
Roberts, Keith .....Chicago, Ill.
Smith, Albert W.....Pueblo, Colo.
Smith, Ralph W.....Denver, Colo.
Snedaker, Eugene G.....Denver, Colo.
Strong, Earle A.....Oneonta, N. Y.
Taylor, Lemuel K.....Golden, Colo.
Tsui, Yulien .....Wu-Chang, China
Turner, John H.....Golden, Colo.
Watrous, Mark U.....Monte Vista, Colo.
Whitaker, Charles N., Jr.....Manrovia, Calif.
Wilfley, Elmer R.....Denver, Colo.
Woolf, Joe H., Jr.....Greeley, Colo.
Wuensch, C. Erb.....Newark, N. J.
Yang, Wei T.....Cheng-tu, China
Zulch, William G.....Denver, Colo.

CLASS OF 1915.

JUNIOR CLASS.

President, Benjamin C. Essig.
Vice-President, James Ord.
Secretary, Rex P. Oliveros.
Treasurer, L. Adair Stewart.

Anderson, Raymond B.....New York, N. Y.
Beall, Alpheus B., Jr.....Sioux City, Iowa
Bebee, Alfred H.....Cripple Creek, Colo.
Berthier, Ulysses H.....Mexico City, Mex.
Boehmer, Max, Jr.....Denver, Colo.
Bolam, Albert E.....Winnemucca, Nev.
Burns, Jay J.....Franklin, Pa.
Burris, Samuel J., Jr.....Pueblo, Colo.
Butner, Daniel W.....Colorado Springs, Colo.
Carlson, Monroe E..... Denver, Colo.
Dammann, A. C. H.....Chicago, Ill.
Davis, Gilmore S.....Trinidad, Colo.
DeLaittre, Horace H.....Minneapolis, Minn.
Dodge, David C., Jr.....Denver, Colo.
Dowden, Ethelbert, Jr.....Plainview, Texas
Duggleby, Alfred F.....Davenport, Iowa
Essig, Benjamin C.....Owosso, Mich.
Franklin, Wells A.....Golden, Colo.
Graham, Allan H.....Ottawa, Ohio
B. S. Ohio Wesleyan University.
Grauting, Hugo G.....Florence, Colo.
Greenwood, John H.....Salt Lake City, Utah
Haselton, Charles F.....Chicago, Ill.
Heatley, F. Eugene .....Denver, Colo.
Hinman, Dale D.....Austin, Colo.
Holt, Frank D.....Webster City, Iowa
Kaanta, Henry W.....Golden, Colo.
Landau, Henry .....Standerton, Transvaal, S. A
Lee, Arthur L.....Milliken, Colo.
Leet, Benjamin ..... Karlo, B. C.
McKnight, Hugh S.....Dallas, Texas
Oliveros, Rex P.....Savannah, Ga.
Olson, Van Cleave A.....Alexandria, Minn.
Ord, James .....Chevy Chase, Md.
Page, Walter C.....Grand Junction, Colo.
Rogers, Charles A.....Salida, Colo.
Rosette, Breese ..... DeKalb, Ill.
Shanley, John R., Jr.....Denver, Colo.
Simon, William W.....Florence, Colo.
Stewart, L. Adair .....Hutchinson, Kan.
Teets, John N.....Red Cliff, Colo.
Thurstin, Robert A.....Bowling Green, Ohio
B. S. Kenyon College.

Tsai, Hsiang .....Hangkow, China
Van Dolah, Parks B.....Victor, Colo.
Van Dorp, Glenn H.....Topeka, Kan.
Walter, Adolph S.....Denver, Colo.
Weller, Simon T.....Denver, Colo.
White, Leonard L.....Golden, Colo.
Wood, Fletcher H.....Mt. Vernon, N. Y.

CLASS OF 1916.

SOPHOMORE CLASS.

President, Charles B. Gauthier.
Vice-President, Kenneth S. Ferguson.
Secretary, Richard M. Fullaway.
Treasurer, Alvah L. Miller.

Beam, John W.....Denver, Colo.
Bicknell, Harold L.....Clarksville, Tenn.
Blaurock, Carl A.....Denver, Colo.
Brenneman, Frederick G.....Eureka, Colo.
Briber, Frank E.....Denver, Colo.
Carstens, Carl E.....Ackley, Iowa.
A. B. Lake Forest College.
Chatin, August H.....Walsenburg, Colo.
Cheney, George M..... Williamstown, Mass.
A. B. Williams College.
Christian, George L.....Leadville, Colo.
Craig, James L.....Dallas, Texas
Ferguson, Kenneth S.....Denver, Colo.
Follansbee, Frank S.....Fort Spring, W. Va.
Fullaway, Richard M.....Los Angeles, Calif.
Garrison, Murray E.....Golden, Colo.
Gauthier, Charles B.....Detroit, Mich.
Hammen, Edwin A.....Chicago, Ill.
Harrod, Wayne A.....Fort Wayne, Ind.
Hornickel, Howard E.....Cleveland, Ohio
Jenni, Walter J.....Pueblo, Colo.
Keese, Jefferson L.....Santo Paulo, Brazil
Lavender, Harry M.....Telluride, Colo.
Lea, Hunyet.....Kwantun, China
Levis, Alfred C.....Baltimore, Md.
Levy, Milton M.....Colorado Springs, Colo.
Lliteras, John M.....Tucson, Ariz.
Miller, Alvah L.....Brooklyn, N. Y.
Mohr, Karl A.....Apalachicola, Fla.
Neelon, Francis A.....Minneapolis, Minn.
Ralph, Walter H.....Valparaiso, Chile
Roll, George H.....Ellsworth, Minn.
Sage, William C.....Rochester, N. Y.
Schoensiegel, Albert D.....Denver, Colo.
Small, Sidney S.....Denver, Colo.
Smith, Frank A.....San Pedro, Calif.
Stringham, William S.....Denver, Colo.
Swigart, Merwyn E.....Carbondale, Colo.
Todd, Clarence T.....Stockton, N. Y.
Traver, Will M., Jr.....Central City, Neb.
Urteaga, Santiago.....Candela, Coahuila, Mex.
Van Burgh, Lisle R.....Denver, Colo.
Wiebelt, Frank J.....Arvada, Colo.
Winchell, John H., Jr.....Edgewater, Colo.

CLASS OF 1917.

FRESHMAN CLASS.

President, William H. Williams.
Vice-President, Arthur W. Stedman.
Secretary, Charles N. Beyrle.
Treasurer, John G. Menke.

Anderson, William J.....Plainview, Texas
Andrews, Thaddeus H.....Walsenburg, Colo.
Besse, Harold N.....Denver, Colo.
Beyrle, Charles N.....Los Angeles, Calif.
Black, Glen W.....Rushville, Neb.
Boot, Harry E.....Denver, Colo.
Breene, Francis H.....Denver, Colo.
Bryan, John R.....Golden, Colo.
Butler, Mifflin M.....Golden, Colo.
Chan, Albert K.....San Francisco, Calif.
Chen, Fan.....Hen Chou, Hunan, China
Chiang, Yung K.....An-Yo Hsien, China
Clifford, John J.....Edgewater, Colo.
Croston, John J.....New York, N. Y.
Cutting, George W.....Florence, Colo.
Dickinson, Earl J.....Denver, Colo.
Durkee, George R.....Omaha, Neb.
Fleming, Charles W.....Silverton, Colo.
Geib, Francis H.....Denver, Colo.
Grübnau, G. Malpass .....Philadelphia, Pa.
Hanno, Oscar E.....Durango, Colo.
Heitzman, Mearle G.....Denver, Colo.
Higgins, Robert .....Pueblo, Colo.
Hofius, Max T.....Belize, British Honduras, C. A.
Hu, Shih H.....Kin Kiang, China
Hummel, Harold R.....Denver, Colo.
Marks, Oscar W.....Sewaren, N. J.
Maxson, Harold F.....Los Angeles, Calif.
Maxwell, Norman E.....Silverton, Colo.
Menke, John G.....Neola, Iowa
Mewhirter, Sydney A.....Denver, Colo.
Moore, Clinton D.....Denver, Colo.
Munn, Harold E.....Golden, Colo.
Nissen, John E.....Arvada, Colo.
Nufio, Gustavo A.....Teguciagalpa, Honduras, C. A.
Olson, Walter.....Arvada, Colo.
Pfrimmer, Walter S.....Bloomington, Ind.
Platt, Douglas H.....Leadville, Colo.
Poss, John R.....New York, N. Y.
Post, John H.....Denver, Colo.
Putnam, Webster F.....Denver, Colo.
Renehan, Lawrence A.....Union City, Conn.
Reynolds, Karl W.....Denver, Colo.

Robinson, Edward W.....Denver, Colo.
Robinson, Harry A.....Lawrence, Mass.
Salzer, Herbert T.....Golden, Colo.
Schneider, Henry G.....Denver, Colo.
Smith, James C.....Franklin, Pa.
Stanfield, R. S. H.....Okmulgee, Okla.
Stedman, Arthur W., Jr.....Boston, Mass.
Steele, Oliver W.....Dallas, Texas
Stotz, Norman I.....Pittsburgh, Pa.
Stouder, Robert D.....Edgewater, Colo.
Taylor, Carroll C.....Plainfield, N. J.
Teets, Charles W.....Red Cliff, Colo.
Weaver, Ralph M., Jr.....Tulsa, Okla.
White, Roger F.....Golden, Colo.
Williams, William H.....Denver, Colo.
Worth, Lee K.....Colorado Springs, Colo.

SUMMARY.

Postgraduates	11
Seniors	60
Juniors	48
Sophomores	42
Freshmen	59
Total	220
Counted twice	11
Net total	209

ALUMNI.

Abel, Walter D., '06.
Adami, Charles J., '99.
Adams, Charles, '04.
Adams, Wilbur E., '00.
Ailinger, Walter J., '13.
Aldrich, Harold W., '06.
Allen, Carl A., '05.
Allen, Maynard C., '06.
Aller, Frank D., '92.
Ambrosius, Carl E., '88.
Anderson, Axel E., '04.
Anderson, Neil A., '02.
Andre, Morris V., Jr., '11.
Andrews, Earle D., '12.
Arfsten, George J., '13.
Armington, H. C., '07.
Arthur, Charles S., '13.
Arthur, Edward P., Jr., '95.
Atkins, Horace H., Jr., '94.
Atkinson, W. J., '96.
Atwater, Maxwell W., '01.
Austin, Arthur, '05.
Badger, Herbert E., '02.
Badgley, Charles W., '06.
Bailey, E. W., '05.
Baker, Hamilton W., '11.
Ball, Byron E., '13.
Ball, Louis R., '00.
Ball, Max W., '06.
Ballagh, J. Courtney, '10.
Banks, Leon M., '12.
Barbour, Percy P., '98.
Barenscheer, William J., '96.
Barker, Franklin L., '06.
Barker, Pierce, '07.
Barnes, Corrin, '96.
Barnett, Walter W., '11.
Barron, Chauncey T., '02.
Bartholomew, Tracy, '06.
Bastanchury, G. A., '07.
Beck, Daniel L., '12.
Beeler, Henry C., '96.
Bell, Charles N., '06.
Bellam, Henry L., '89.
Benjovsky, T. D., '09.
Benwell, George A., Jr., '00.
Benner, Howard C., '13.
Bergh, John E., '02.
Berry, Albert, '05.
Berthoud, Capt. E. L.
Bertschy, Perry H., '98.
Bigley, Arthur C., '13.
Billyard, John R. H. H., '13.
Bishop, Raymond, '01.
Bisland, John B., '13.
Blackburn, Ward, '08.
Block, Gary E., '08.
Blow, A. A. Hon. E. M., '10.
Blum, Sidney, '11.
Blumenthal, Emil E., '98.
Bowie, James W., '94.
Bowman, Frank C., '01.
Bowman, Reginald G., '11.
Boyd, Jesse T., '08.
Boyle, Willis J., Jr., '12.
Bradford, Albert H., '09.
Bradford, Julius S., '10.
Bradley, Joseph M., '01.
Brandt, A. R., '07.
Breed, Charles F., '01.
Brinker, Arthur C., '01.
Brinker, Albert W., '08.
Bronstein, Charles N., '13.
Brooks, Eugene C., '10.
Brown, C. Leroy, '08.
Brown, John B., '06.
Brown, Norton H., '92.
Brown, R. L., '05.
Brown, Samuel R., Jr., '11.
Brown, Walter R., '10.
Bruce, Harry F., '00.
Bruce, James L., '01.
Bruce, Stuart S., '99.
Bruderlin, Emil J., '10.
Brunel, Frank P., '12.
Brunel, Rene L., '06.
Bryan, Russell R., '08.
Bucher, John W., '02.
Buck, Arthur H., '97.
Budrow, William B., '92.
Buell, Arthur W., '08.
Bulkley, Frank, Hon. E. M.
Bumsted, Edward J., '01.
Bunger, Milne E., '09.
Burgess, Charles W., '09.
Burlingame, Walter E., '01.
Busey, A. P., Jr., '05.
Bussey, Edwin E., '97.
Butler, G. Montague, '02.
Cain, Louis S., '13.
Calvert, Clarence E., '12.
Campbell, Kent P., '10.

Canning, Herbert A., '97.
Canning, Walter E., '09.
Carman, John B., '10.
Carney, Hugh J., '04.
Carpenter, Cranston H., '09.
Carpenter, Paul H., '10.
Carstarphen, F. C., '05.
Cary, Webster P., '10.
Chamberlin, W. O., '05.
Chandler, John W., Jr., '01.
Chapman, Irving A., '13.
Chapman, Thomas L., '06.
Charles, Lavern J., '02.
Chedsey, William R., '08.
Christensen, Walter, '02.
Church, Myron J., '98.
Clapp, Leroy P., '09.
Clark, George B., '01.
Clark, Winfred N., '98.
Clausen, Samuel J., Jr., '11.
Cline, Seymour F., '08.
Coghill, Will H., '03.
Cohen, Louis, '97.
Colburn, C. L., '07.
Cole, Burt, '92.
Coleman, R. Prewitt, '03.
Collbran, Arthur H., '02.
Collins, Phillip M., '93.
Collins, Shrive B., '01.
Comstock, Charles W., '90.
Copeland, Clarence E., '13.
Corry, Arthur V., '98.
Corson, N. G., '07.
Cory, J. J., '05.
Cowperthwaite, Edward W., '13.
Cox, Augustus D., '03.
Cox, W. Ray, '02.
Craigue, William H., '89.
Cramer, Curtis P., '99.
Cronin, Harry M., '13.
Crow, Wade L., '01.
Crowe, Thomas B., '00.
Cuno, A. F., '05.
Currens, Warren W., '12.
Curtis, Roy P., '09.
D'Arcy, R. L., '05.
Daman, C. J., '13.
Dauth, Herman, '13.
Davenport, John, '12.
Davey, William R., '98.
Davis, Carl R., '95.
Davis, Gilbert L., '99.
Davis, John R., '13.
De Camp, W. Val., '08.
De Cou, Ralph E., '01.
De Sollar, Tenney C., '04.
Dick, James E., '12.
Divinney, George V., '03.
Dilts, Ira J., '08.
Dittus, Edward J., '11.
Dockery, L. A., '95.
Dollison, James E., '98.
Douglas, William C., '11.
Dove, Dean R., '13.
Dow, William G., '06.
Downer, Roger H., '01.
Downes, Frank A., '13.
Doyle, Donald B., '09.
Draper, Marshall D., '97.
Drescher, Frank M., '00.
Dudgeon, James W., '13.
Duer, C. L., '05.
Dunkle, Fred W., '03.
Dunlevy, Forrest S., '08.
Du Rell, Charles T., '95.
Dwelle, Jesse E., '96.
Dyer, Charles E., '10.
Dyrenforth, Donald, '12.
Eames, L. B., '05.
East, John H., Jr., '10.
Eaton, Albert L., '95.
Eaton, Walter J., '13.
Eddy, Harold C., '09.
Ehle, Mark, Jr., '01.
Ehrich, Walter L., '02.
Elder, Robert B., '08.
Ellis, T. P., '07.
Ellis, William W., '02.
Ellsworth, Alfred C., '08.
Emeis, Walter A., '04.
Emens, Ray B., '07.
Emrich, Clarence T., '09.
Emrich, Horace H., '03.
Emrich, Jay L., '12.
Engle, Frederick, '11.
Enriquez, Edward W., '09.
Erickson, Guy W., '12.
Estes, Frank M., Jr., '02.
Evans, Henry R., '00.
Evans, Willis W., '08.
Everest, Herbert A., '08.
Ewing, Charles R., '00.
Eye, Clyde M., '95.
Farnam, Lynn C., '09.
Farrar, Russell J., '10.
Fay, Charles H., '13.
Fay, Herbert M., '13.
Febles, John C., '97.
Field, Edmund M., '12.
Field, Fred M., '95.
Fillius, Lee L., '04.
Filteau, C. A., '07.
Finigan, William H., '06.
Fitz Gerald, Ronald P., '10.
Fleming, William L., '03.
Flinn, Alfred, '13.

Flint, F. F., '05.
Floyd, John A., '88.
Forbes, Henry H., '13.
Ford, Homer D., '05.
Foster, George C., '03.
Franck, Albert C., '04.
Franck, Robert P., '04.
Frank, Harry L., '01.
Frank, Morton E., '06.
Frankel, Jacob M., '13.
Frazee, Verne, '12.
Freeland, William H., '06.
French, Burr J., '08.
French, Clare L., '13.
French, Sidney W., '08.
Frey, Carl E., '13.
Frick, Frederick F., '08.
Friedhoff, W. H., '07.
Fry, Louis D., '03.
Fullerton, Wilfred, '12.
Funk, Walter A., '03.
Galligan, John T., '11.
Gardner, John I., '06.
Garnett, Thomas H., '11.
Garza, Aldape J. M., '05.
Gaul, John C., '12.
Geary, E. S., '12.
Geary, Richard E., '09.
Gehrman, Charles A., '86.
Geib, Karl V., '11.
Geisel, C. R., '07.
Geringer, George T., '10.
Giddings, Donald S., '00.
Gilbert, Arthur K., '06.
Gilbert, William J., '06.
Glasgow, Charles M., '10.
Goe, Harold H., '08.
Golden, J. P., '07.
Goodale, F. A., '10.
Goodale, Stephen L., '04.
Gordon, John G., Jr., '06.
Gow, P. A., '07.
Grant, Lester S., '99.
Gray, Latimer D., '95.
Greensfelder, Nelson S., '12.
Gregg, Daniel B., '13.
Greve, E. E., '05.
Grider, R. L., '05.
Grier, Charles D., '12.
Griffith, John R., '09.
Griswold, George G., '96.
Grommon, Philo D., '07.
Gross, John, '97.
Hager, E. T., '12.
Hale, General Irving, Hon.
Hallett, Alfred F., '09.
Hallett, R. L., '05.
Hallett, William J., '05
Hamilton, Frank R., '98.
Hamilton, William J., '09.
Hammond, John Hays, Hon., '09.
Hammond, Herbert R., '13.
Hammond, William L., '09.
Hansen, Charles L., '09.
Harkison, Charles W., '06.
Harrington, Charles L., '12.
Harrington, Daniel, '00.
Harrington, Orville, '98.
Harris, Arnold W., '12.
Harris, Frank B., '13.
Harris, Morrison, '08.
Harris, Willard F., '01.
Harrison, Thomas S., '08.
Hartzell, Lester J., '95.
Harvey, John V., '11.
Hawley, R. H., '93.
Hazard, William J., '97.
Heaton, Charles D., '12.
Heinrichs, Walter E., '13.
Heitz, George H., '06.
Hensley, James H., Jr., '06.
Herres, Otto, Jr., '11.
Hewitt, A. F., '05.
Hiester, Arthur J., '12.
Hill, Charles R., '12.
Hill, Frank C., '04.
Hills, Leon P., '08.
Hilsdale, Paul, '12.
Hilton, Howard J., '10.
Hindry, Willis E., '92.
Ho, Chieh, '13.
Hodgson, Arthur R., '99.
Hollis, D. D., '07.
Hornbein, Julius, '05.
Howat, A. M., '07.
Hoyt, George F., '96.
Hubbard, John V., '10.
Hudson, Waller C., '13.
Hughes, Earle E., '12.
Hugo, Herman W., '13.
Hull, Cecil B., '09.
Hunt, Harry D., '09.
Hunt, T. R., '05.
Huntington, Walter C., '12.
Hyder, C. A., '05.
Hyder, Frederick B., '03.
Ickis, Harry M., '02.
Ingersoll, Julius C., Jr., '06.
Ingols, James A., '98.
Ireland, Carrol B., '08.
Isom, E. W., '07.
Iwai, Kyosuke, '09.
Izett, Glenn, '03.
Jackson, Walter H., '01.
Jacques, Henry L., '08.
Jarvis, Dr. Royal P., '97.

Jewel, Gilbert E., '93.
Johnson, Byron M., '08.
Johnson, Edward W., '91.
Johnson, Gilbert, Jr., '99.
Johnson, Junius W., '01.
Johnson, Lafayette G., '04.
Johnston, Fred, '98.
Jones, Edward B., '00.
Jones, Ernest F., '10.
Jones, Mrs. F. H., '98.
Jones, Frank H., '98.
Jones, Fred, '00.
Jones, Percy, Jr., '08.
Jones, Vincent K., '10.
Jones, W. A., Jr., '08.
Juchem, Harold H., '10.
Keeney, Robert M., '10.
Kell, Wayne S., '06.
Kelley, Fred G., '99.
Kelly, William A., '97.
Kelso, Duane C., '10.
Kennedy, George A., '95.
Kenner, A. R., '07.
Kerr, Victor E., '00.
Kilbourn, Burwell N., '13.
Kilbourn, William D., '04.
Kilgour, Hamilton, '08.
Kimball, George K., '92.
Kimball, Harlow M., '04.
Kimball, Joseph S., '92.
King, Henry E., '03.
Kingman, Jerry, '88.
Kirchman, Robert I., '09.
Kissock, Alan, '12.
Kleff, J. M., '06.
Knight, Hal G., '08.
Knight, R. E., '07.
Knowles, Benjamin W., '08.
Koch, William F., '11.
Koerner, Albert J., '06.
Kraemer, Edward L., '98.
Krueger, G. S., '07.
Kruger, Herman A., '09.
Lampe, Oscar A., '98.
Langrall, Charles A., '08.
Lannon, F. P., Jr., '07.
Lannon, James A., '11.
Larison, E. L., '05.
Larsh, Walter S., '04.
Latimer, Bertrand J., '10.
Laughlin, Samuel W., '10.
Laurance, Bert M., '11.
Leahy, Richard A., '13.
Lee, Frank W., Jr., '11.
Lee, George M., '10.
Lee, Robert P., '05.
Lee, Wallace, '04.
Leeke, Dana W., '10.
Lehmer, Frank W., '02.
Lemke, Carl A., '00.
Lennox, Luther W., '05.
Lerchen, F. H., '97.
Lesh, Herbert B., '10.
Lesher, Carl E., '08.
Levy, Archibald L., '06.
Lewis, Alfred S., '05.
Lewis, Frank E., '01.
Lewis, William B., '92.
Lewis, William M., '09.
Libby, James L., '06.
Liddell, Charles A., '03.
Liddell, T. P., '03.
Light, Victor A., '13.
Limbach, Edmund C., '95.
Link, Karl G., '08.
Logue, N. W., '97.
Lonergan, P. Jay, Jr., '05.
Lorah, Bela J., '88.
Lovering, Ira G., '01.
Lowell, James B., '08.
Lucy, Frank Allen, '01.
Lucy, Richard W., '98.
MacGregor, George H., '97.
MacKay, Donald R., '12.
Magenau, William, '98.
Malmstrom, C. C., '00.
Marrs, George O., '01.
Marshall, Emory M., '11.
Martin, J. A., '07.
Martinez, Fidel, '13.
Matheson, Kenneth, H., '11.
Mathews, Harvey, '13.
Matteson, Wallace G., '11.
Maxwell, Fred A. G., '95.
May, Andrew J., Jr., '12.
May, Arthur L., '11.
May, John G., '01.
May, Ross R., '12.
Mayer, Walter J., '11.
Maynard, Rea E., '96.
McCallum, Jean, '10.
McCart, Robert, Jr., '05.
McCormick, David F., '10.
McDaniel, Alexander K., '01.
McDermutt, Grace C. U., '03.
McDonald, Jesse F., Hon.
McElvenny, Robert F., '03.
McGregor, M. S., '13.
McHugh, Philip M., '11.
McKay, Glover S., '10.
McLeod, J. N., '97.
McMahan, Charles H., '92.
Medell, William S., '95.
Merryman, Herbert E., '95.
Mertes, Albert T., '12.
Merwin, E. W., '03.

Middelkamp, L. L., '05.
Middleton, William B., '83.
Millard, Frank W., '01.
Miller, De Mont G., '09.
Milliken, John T., '96.
Milliken, William B., '93.
Mitchell, George B., '96.
Montrose, James F., '02.
Moore, C. A., '12.
Moore, C. F., '07.
Moore, George P., '07.
Moss, Cleveland O., '02.
Moynahan, Ambrose E., '00.
Muir, David R., '99.
Muir, Douglas, '05.
Murch, Clarence H., '08.
Murchison, E. H., '12.
Myers, John F., '13.
Nagel, Frank J., '03.
Nagel, Henry P., Jr., '04.
Nance, William H., '96.
Neiswender, Chester B., '13.
Nelson, H. E., '97.
Neugebauer, Karl E., '06.
Neville, J. B., Jr., '05.
Newnam, William E., '96.
Nicholson, George W., '00.
Nieman, Earl F., '13.
Nolan, Philip E., '13.
Norman, J. E., '98.
Norton, A. C., '07.
Nyberg, H. E., '06.
Nye, Robert, '97.
O'Byrne, Joseph F., '05.
Olsen, Charles O., '11.
Oram, Charles F., '13.
Osborne, Arthur H., '93.
Page, Lawrence C., '08.
Palsgrove, Harry G., '03.
Paredes, Evaristo, '05.
Parker, James H., '95.
Parks, George A., '06.
Parrish, Karl C., '01.
Parsons, F. H., '07.
Parsons, Horace F., '03.
Patrick, William B., '09.
Patterson, S. B., Jr., '06.
Paul, Russell B., '02.
Paul, William H., '96.
Pendery, John M., '00.
Peregrine, William D., '13.
Perkins, Alfred S., '10.
Pfeiffer, G. N., '05.
Phelps, Harlow D., '10.
Phelps, W. B., '07.
Pilger, Newton W., '06.
Place, J. Sterling, '13.
Platt, Edwin H., '00.
Post, George M., '94.
Powell, George F., '97.
Powers, Oliver, '02.
Pray, Milton A., '08.
Pray, Winfred A., '01.
Pressler, L. P., '05.
Price, Harold C., '13.
Price, Lyttleton, Jr., '00.
Prier, Truman D., '04.
Prior, Charles E., '13.
Prout, John, '00.
Pullen, Lester L., '10.
Purdy, Irvine A., '10.
Putnam, George B., '05.
Quayle, T. W., '07.
Rabb, E. M., '05.
Rambo, W. C. J., '09.
Ramlow, W. G., '12.
Ramsey, E. R., '12.
Ransom, Rastus S., Jr., '13.
Rath, C. M., '05.
Reinhard, Frank J., '05.
Reno, Charles F. A., '08.
Reno, Horace T., '02.
Rhodes, William B., '03.
Rich, Joseph U. G., '08.
Richards, E. R., '05.
Richards, John V., '02.
Richardson, Allan S., '12.
Ripley, George C., '06.
Rising, Arthur F., '99.
Ristedt, Ernest J., '09.
Roberts, Henry M., '12.
Robey, Lloyd, '00.
Robinson, George P., '04.
Rockwood, Carl A., '12.
Rodriquez, J. C., '98.
Roller, Arthur H., '97.
Root, Charles D., '08.
Ross, George M., '07.
Rowe, Charles E., '02.
Rowe, Edward E., '95.
Royer, Frank W., '99.
Rudd, Arthur H., '00.
Rusman, Benjamin A., '13.
Russell, Donald O., '09.
Ryan, W. E., '05.
Sackett, Blair L., '09.
Saint Dizier, Julius L., '94.
Sale, Andrew J., '01.
Sandusky, Samuel C., '08.
Saxton, Frank B., '12.
Schafer, Louis, '09.
Scheble, Max C., '01.
Schellenberg, G. W., '12.
Schlereth, C. Q., '06.
Schneider, August W., '11.
Schneider, George W., '94.

Schuman, Enrique A., '97.
Shaver, F. J., '07.
Shaw, Ralph H., '11.
Sherman, Scott H., '04.
Shetler, Waverly, '95.
Showman, Harry M., '10.
Sill, Rush T., '06.
Silver, Leopold, '10.
Simpson, William P., '01.
Skavlem, Henry G., '10.
Skinner, Lewis B., '95.
Slater, Amos, '00.
Sloan, W. A., '03.
Small, Harvey B., '01.
Smith, C. Dupree, '91.
Smith, Claude H., '00.
Smith, E. M., '05.
Smith, Harry C., '98.
Smith, Howard C., '13.
Smith, Roy F., '11.
Smith, Thomas G., '99.
Snow, Robert E., '11.
Solomon, Irwin R., '13.
Soupcoff, Samuel M., '10.
Spangler, Howard, '05.
Spencer, Walter I., '04.
Spring, Archer, '12.
Stannard, Burt C., '95.
Starbird, Edwin P., '01.
Starbird, H. B., '97.
Steele, James H., '00.
Stein, Edmund, '13.
Steinhauer, Fred C., '99.
Stephens, Charles N., '98.
Stephens, Frank M., '13.
Stephens, Wallace A., '93.
Stephenson, T. E., '06.
Stewart, Hugh A., '12.
Stockton, Robert S., '95.
Stoeckley, E. F., '05.
Storm, Lynn W., '02.
Stotesbury, H. W., '07.
Street, Gerald B., '01.
Strohl, George F., '10.
Stronck, Hubert N., '13.
Strout, Fred McL., '96.
Stuart, Malcolm M., '08.
Suhr, Otto B., '95.
Swainson, Otis W., '10.
Swanson, C. Arthur, '13.
Taggart, George K., '03.
Taggart, Oliver R., '09.
Taylor, Harry Picotte, '00.
Terrill, A. C., '05.
Tescher, Samuel, '04.
Thomas, John S., '04.
Thomas, Lester C., '12.
Thompson, James S., '99.
Thomson, A. T., '05.
Thomson, Francis A., '04.
Thum, Ernest E., '06.
Thurston, Ralph V., '11.
Titsworth, Frederick S., '95.
Toenges, Albert L., '12.
Townsend, Arthur R., '99.
Trott, Maynard J., '08.
Trott, Roland S., '06.
Trueheart, Lawrence G., '13.
Trumbull, Loyal W., '04.
Tyler, Sidney B., '99.
Utley, Howard H., '00.
Vacek, Vincent F., '10.
Valentine, Malvern R., '98.
van Diest, Edmond C., '86.
Van Wagenen, Hugh R., '06.
Vaughn, Robert M., '04.
Voelzel, Gustave W., '11.
Wackenhut, George J., '04.
Walker, A. D., '12.
Wallace, Howard J., '04.
Wallace, Louis R., '95.
Waltman, Will D., '99.
Wang, Shoa-Ying, '13.
Ward, Merwin H., '13.
Ward, William F., '03.
Warfel, C. G., '07.
Warnecke, Carl M., '97.
Warren, Seymour P., '13.
Washburn, Howard G., '04.
Wasley, William A., '09.
Watson, Guy P., '10-'12.
Watson, Hugh C., '01.
Watson, Samuel E., '13.
Wattles, William C., '03.
Watts, Alfred C., '02.
Weed, Floyd, '97.
Weil, Jacob, '04.
Weinig, Arthur J., '08.
Weir, John A., '09.
Weiss, Andrew, '99.
Weisz, Joseph J., '09.
Wells, Ben T., '04.
Wells, Frank B., '03.
Wertheim, Salomonson F. M. G. A., '89.
West, John R., '10.
Wheeler, Charles E., '94.
Wheeler, Robert M., '08.
Whitaker, Orvil R., '98.
White, J. L., '07.
Whitehead, Paul, '12.
Whitehouse, Howard D., '08.
Whitehurst, J. W., '10.
Wigton, George H., '13.
Wilcoxson, Edward D., '12.
Wiley, Walter H., '83.

Wilfley, George, '13.
Wilkinson, Mearle W., '13.
Williams, Fred T., '01.
Williams, Irving B., '11.
Williams, John C., '13.
Williams, Wakely A., '99.
Wilson, Dudley M., '09.
Wolf, A. G., '07.
Wolf, Harry J., '03.
Wong, William A., '13.
Wood, Ernest B., '09.
Woods, Thomas H., '97.
Wraith, Charles R., '11.
Wright, Thomas W., '13.
Youker, C. Norman, '12.
Young, Frank B., '95.
Young, Peter A., '13.
Zulch, Herman C., '08.
Zwetow, Arthur N., '11.

INDEX.

Page
Admission Requirements 38-42
Advanced Analytic Geometry, Course in....104
Advanced Calculus, Course in 104
Advanced Engineering Drawing, Course in 85
Advanced General Metallurgy, Course in.... 68
Advanced Metallography, Course in.... 68
Advanced Projection, Course in.... 84
Advanced Standing, Admission to 42
Algebra, Courses in 101, 102
Alternating Current Machinery, Courses in....81, 82
Alumni 142
Alumni Association 132
Analytic Geometry, Courses in 103
Applied Electricity, Courses in 82, 83
Assay Laboratory 23, 31
Assaying, Courses in 60, 61
Astronomy, Courses in 106
Athletics and Physical Training, Department of....132
Board, Cost of 126
Board of Trustees 11
Books, Cost of 126
Buildings 23-25
Business Correspondence, Course in 107
Calculus, Courses in 103, 104
Calendar 9
Campus, Illustration 18
Carpenter Shop 25
Ceramic Geology, Course in 74
Chemical Laboratories 32
Chemistry, Courses in 92-97
Chemistry, Hall of 23
Civil Engineering, Courses in 76-80
Coal Mining, Short Course in 125
Collections, Geological and Mineralogical 29
College Algebra, Course in 101, 102
Commercial Ores, Collection of 29
Compressed Air, Course in 87
Conditions 128
Copper, Course in the Metallurgy of 64
Crystallography, Course in 71
Degrees 42
Departments of Instruction—
Mining 52-59
Metallurgy 60-69
Geology and Mineralogy 70-75
Civil Engineering 76-80
Electrical Engineering 81-83
Mechanical Engineering 84-91
Chemistry 92-97

Page
Physics 98-100
Mathematics 101-106
English 107
Modern Languages 108-110
Mining Law 111
Deposits 125
Descriptive Geometry, Course in 84
Differential Equations, Course in 105
Diplomas 43
Direct Current Machinery, Courses in 81
Drawing Rooms 37
Economic Geology, Courses in 75
Economics of Mining, Course in 58
Electrical Laboratory 34
Electrical Plant Trips 119
Electricity, Special Apparatus and Appliances, Course in.... 83
Electrometallurgy, Courses in 66, 68
Electrometallurgical Laboratory 33
Electrical Engineering, Courses in 81-83
Electrical Engineering, Special Apparatus, Course in 82
Electrochemical Analysis, Course in 96
Engineer Company, N. G. C....127
Engineering Construction, Course in 79
Engineering Drawing, Course in 84
Engineering Mathematics, Course in 105
English, Courses in 107
Enrolment of Students 134
Entrance Examinations 39
Entrance Requirements 38-42
Equipment 26-37
Exchanges, Geological and Mineralogical 30
Experimental Ore Dressing and Metallurgical Plant..4, 25, 26-29
Expenses—
Tuition 124
Fees and Deposits 124, 125
Board and Lodging 126
Books and Students' Supplies 126
Other Expenses 126
Faculty 12, 13
Failures 128
Fees 124
Field Geology, Courses in 73
Financial Support 22
First Aid and Rescue Work, Course in 54
French, Courses in 109
General Chemistry, Courses in 92
General Geology, Courses in 70, 71
General Information 124
General Physics, Courses in 98, 99
Geological Exchanges 30
Geological Laboratory and Cabinet 29
Geological and Topographical Maps, Course in 74
Geology, Courses in 70-75
Geology, Historical, Courses in 72, 73
Geology of Coal, Oil, and Gas, Course in 75
Geometry, Analytic, Course in 103
Geometry, Descriptive, Course in 84

Page
German, Courses in 110
Gold, Course in the Metallurgy of 64
Grading, Method of 128
Graduation 43
Gymnasium 23
Heating, Lighting, and Power Plant 24
History of the School 21
Hydraulic Laboratory 32
Hydraulics, Courses in 78, 79
Hydroelectric Power Development, Course in..... 59
Hydrostatics, Course in 78
Industrial Chemistry, Courses in 95
Industrial Chemistry Trips 119
Inspection Trips 112
Integral Club 131
Internal Combustion Engines, Course in 89
Iron, Courses in the Metallurgy of 61, 62
Laboratories and Equipment 26
Lead, Courses in the Metallurgy of 62, 63
Lecturers, Special 15, 16
Library 129
Lithology, Course in 72
Location and Description 19, 20
Lodging, Cost of 126
Machine Design, Courses in 85
Machine Shop 25
Magazine, The Alumni 132
Mathematics, Courses in 101-106
Mechanical Engineering, Courses in 84-91
Mechanical Engineering Laboratory 36, 88
Mechanics of Engineering, Courses in 77
Mechanics of Engineering Laboratory 34
Mercury, Course in the Metallurgy of 64
Metallography, Courses in 67, 68
Metallurgical Chemistry, Courses in 95
Metallurgical Collections 30
Metallurgical Laboratory 30
Metallurgical Laboratory, Course in 65
Metallurgical Plant Design, Course in 69
Metallurgical Practice, Courses in 63, 65
Metallurgical Trips 120
Metallurgy, Courses in 60-69
Metallurgy of Iron and Steel, Courses in 61, 62
Metallurgy of Lead and Zinc, Courses in.....62, 63
Metallurgy of Gold, Silver, and Copper, Course in 64
Microscopic Petrography, Course in 74
Mineral Land Surveying, Courses in 52, 53
Mineralogical Exchanges 30
Mineralogical Laboratory and Cabinet 29, 30
Mineralogy, Course in 71
Mine Accounting, Course in 54
Mine Equipment, Course in 59
Mine Examinations and Reports, Course in 57
Mine Management, Course in 58
Mine Mapping, Course in 53
Mine and Mill Plant Design, Course in 90
Mine Plant Testing, Course in 90

Page
Mine Surveying, Courses in 52, 53
Mining, Coal, Courses in 57
Mining Corporations, Course in 56
Mining, Economics of, Course in 58
Mining, Courses in 52-59
Mining Laboratory 35
Mining Laboratory, Course in 56
Mining Law, Course in 111
Mining, Metal, Courses in 55
Mining, Placer, Course in 54
Mining Trips 118
Modern Languages, Courses in 108-110
Museum, Geological and Mineralogical 30
Museum of Applied Chemistry 32
Nickel, Course in the Metallurgy of 64
Ore Deposits, Course in 75
Ore Dressing, Course in 63
Ores, Collection of 29
Organization 21
Petrography, Course in 74
Physical Chemistry, Course in 96
Physical Laboratories 33
Physics, Courses in 98-100
Physics, Hall of 24
Plane Surveying, Courses in 76
Postgraduate Students 134
Power Plant 24
Power Plant Design, Courses in 88, 89
President, Office of 23
President, Residence of 25
Prizes 131
Pumping Machinery, Course in 87
Qualitative Analysis, Courses in 92, 93
Quantitative Analysis, Courses in 93, 94
Quarterly, The 127
Radioactivity and Spectroscopy, Course in 99, 100
Radioactivity and Spectroscopy, Laboratories in 36
Rare Metals, Course in 95
Rare Metals Laboratory 24
Registrar, Office of 23
Requirements for Admission to the Freshman Class 38
Requirements for Admission to Advanced Standing 42
Rescue Work, Course in 54
Research Work 28
Scientific Society 131
Senior Trip 112
Short Course in Coal Mining 125
Silver, Course in the Metallurgy of 64
Simon Guggenheim Hall 23
Social Life 132
Special Lecturers 15, 16
Spanish, Courses in 108, 109
Standing Committees of Faculty 14
Steam Engines and Boilers, Courses in 86, 87
Steel, Courses in the Metallurgy of 61, 62
Stoichiometry, Courses in 96
Stratton Hall 24

Page
Structural Details, Course in 80
Students, Enrolment of 134
Summer School 127
Support, Financial 22
Surveying, Courses in 52, 53, 76
Surveying Equipment 31
Table of Contents 7
Tabular Views 46-51
Technical Writing, Course in 107
Testing Laboratory for Mechanics of Engineering 78
Testing Plant 26-29
Text-Books, Cost of 126
Theoretical Chemistry, Courses in 97
Theory of Equations, Course in 104
Theses 43
Trigonometry, Courses in 102
Trustees, Board of 11
Tuition 124
Vector Analysis and Quaternions, Course in 105
Y. M. C. A. 129
Zinc, Courses in the Metallurgy of 62, 63

THE W. F. ROBINSON

THE
JOHN CRERAR
LIBRARY

QUARTERLY

Vol. XII No. 1

217-1248

Entered as second-class mail matter July 10, 1906, at the Post Office at Golden, Colorado, under the Act of Congress of July 16, 1894

THE
NEWBERRY
LIBRARY

School of Mines and Part of Golden, Colorado

QUARTERLY

of the

COLORADO SCHOOL OF MINES

Vol. XII No. 1

Catalogue Edition

GOLDEN, COLORADO

1917

SW

The Experimental Ore Dressing and Metallurgical Plant, Colorado School of Mines

TABLE OF CONTENTS

(For complete index see page 161.)

Page
School Calendar 9
Board of Trustees 10
Faculty 11
Standing Committees of the Faculty 13
Special Lecturers 14
Location and Description 17
History 19
Organization 19
Financial Support 20
Buildings 21
Laboratories and Equipment 24
Requirements for Entrance 34
Departments of Instruction 41
- Tabular Views 42
- Fees 51
- Mining 53
- Metallurgy 63
- Geology and Mineralogy 68
- Civil Engineering 74
- Electrical Engineering 79
- Mechanical Engineering 82
- Chemistry 88
- Physics 94
- Mathematics 97
- English 105
- Modern Languages 107
- Safety Engineering 109
- Inspection Trips 112

General Information 113
Course for Prospectors 113
Enrollment of Students 123
Alumni 130
Index 161

SCHOOL CALENDAR

1917

January 6, Saturday	Christmas Recess ends
January 20, Saturday	First Semester ends
January 22, Monday	Second Semester begins
February 5, Monday	Course for Prospectors begins
February 12, Monday	Lincoln's Birthday (A Holiday)
February 22, Thursday	Washington's Birthday (A Holiday)
March 3, Saturday	Course for Prospectors ends
May 25, Friday	Second Semester ends Commencement Exercises
May 28, Monday	Summer Field Work begins
July 7, Saturday	Summer Field Work ends
August 29, Wednesday August 30, Thursday August 31, Friday	Examination for Entrance to the Class of 1921, and Re-examination of Matriculated Students
September 3, Monday September 4, Tuesday	Registration
September 5, Wednesday	Opening of the First Semester of the Academic Year 1917-18
September 17, Monday	No Registrations after this Date
November 29, Thursday November 30, Friday December 1, Saturday	Thanksgiving Recess
December 24, Monday	Christmas Recess begins

1918

January 5, Saturday	Christmas Recess ends
January 26, Saturday	First Semester ends
January 28, Monday	Second Semester begins
February 4, Monday	Course for Prospectors begins
February 12, Tuesday	Lincoln's Birthday (A Holiday)
February 22, Friday	Washington's Birthday (A Holiday)
March 2, Saturday	Course for Prospectors ends
May 31, Friday	Second Semester ends Commencement Exercises
June 3, Monday	Summer Field Work begins
July 13, Saturday	Summer Field Work ends

BOARD OF TRUSTEES

FRANK G. WILLIS, E. M., Cripple Creek, Colo.
President
Term expires 1917

JAMES T. SMITH, Denver, Colo.
Secretary
Term expires 1917

ORVILLE R. WHITAKER, E. M., Denver, Colo.
Term expires 1919

HARRY M. RUBEY, Golden Colo.
Treasurer
Term expires 1919

The regular meetings of the Board of Trustees are held in Golden at the School of Mines on the second Thursday of each month.

FACULTY

HOWARD C. PARMELEE, A. M., (University of Nebraska)
President

REGIS CHAUVENET, B. S., (Harvard) A. M., L. L. D., (Washington University)
President Emeritus
Special Lecturer in Metallurgy and Chemistry

PAUL MEYER, Ph. D., (Giessen)
Professor Emeritus of Mathematics

HORACE BUSHNELL PATTON, Ph. D., (Heidelberg)
Professor of Geology and Mineralogy

CHARLES ROLAND BURGER, A. B., (Harvard)
Professor of Mathematics

WILLIAM JONATHAN HAZARD, E. E., (Colorado School of Mines)
Professor of Electrical Engineering

RANSOM SMITH HAWLEY, B. S., M. E., (University of Michigan)
Professor of Mechanical Engineering

HARRY JOHN WOLF, E. M., M. S., (Colorado School of Mines)
Professor of Mining

JAMES COLE ROBERTS, Ph.B., (University of North Carolina)
Professor Safety Engineering

GEORGE J. YOUNG, B. S., (University of California)
Professor of Metallurgy

CLAUDE CORNELIUS VAN NUYS, B. S., E. M., (South Dakota School of Mines); A. M., (Columbia University)
Professor of Physics

WILLIAM GEORGE HALDANE, B. S., (Case School of Applied Science)
Associate Professor of Metallurgy

GEORGE EULAS FOSTER SHERWOOD, A. M., (Harvard)
Associate Professor of Mathematics

VICTOR ZIEGLER, A. M., (Columbia University)
Associate Professor of Geology and Mineralogy

CHARLES DARWIN TEST, B. M., E. A. C., (Purdue University)
Assistant Professor of Chemistry

JOHN CHRISTIAN BAILAR, A. M., (University of Colorado)
Assistant Professor of Chemistry

HARRY MUNSON SHOWMAN, E. M., (Colorado School of Mines)
Assistant Professor of Civil Engineering

CARROLL GEORGE DOLMAN, A. B., (Harvard)
Assistant Professor of English and Modern Languages

RALPH ROY KNOWLES, B. S., (Worcester Polytechnic Institute)
Instructor in Electrical and Mechanical Engineering and Mining

FREDERICK WILLIAM LUCHT, Jr., B. E., (University of Michigan)
Instructor in Mechanical Engineering

FRED G. CARTER, A. B., (University of Wisconsin)
Athletic Director

THOMAS COURTLAND DOOLITTLE,
Registrar and Business Manager

PEARL GARRISON, M. Di., (Iowa State Normal School)
Librarian

ALICE B. LYLE,
Secretary to the President

FRIEDA M. WATKINS,
Stenographer to the Faculty

ARTHUR L. RAE,
Superintendent of Grounds and Buildings

HENRY J. GUTH,
Pattern Maker

F. H. EYER,
Stock Clerk

President of the Faculty
HOWARD C. PARMELEE

Secretary of the Faculty
HARRY MUNSON SHOWMAN

Standing Committees of the Faculty

Committee on Catalogue

PROFESSOR WOLF PROFESSOR SHERWOOD
PROFESSOR YOUNG

Committee on Registration

PROFESSOR SHERWOOD PROFESSOR SHOWMAN
PROFESSOR PATTON PROFESSOR HAWLEY
PROFESSOR HALDANE PROFESSOR WOLF

Committee on Courses of Study and Schedule

PROFESSOR PATTON PROFESSOR WOLF
PROFESSOR SHERWOOD

Committee on High School Scholarships

PROFESSOR WOLF PROFESSOR YOUNG
PROFESSOR BURGER

Students' Loan Fund Committee

PROFESSOR HAWLEY PROFESSOR BURGER
PROFESSOR HAZARD

Students' Welfare Committee

PRESIDENT PARMELEE PROFESSOR PATTON
PROFESSOR HAWLEY PROFESSOR HAZARD

Faculty Representative Rocky Mountain Faculty Athletic Conference

PRESIDENT PARMELEE

SPECIAL LECTURERS

HIS EXCELLENCY GOVERNOR GEORGE A. CARLSON
The Function of the School of Mines

HON. EDWARD T. TAYLOR, Glenwood Springs, Colo.
The Panama Canal

FRANK E. SHEPARD, Denver Colo.
President Denver Engineering Works Company
The Development of Modern Mill Systems
Recent Advances in Coarse Crushing

WALTER G. SWART, Duluth, Minn.
Mining Engineer
Recent Developments in Dry Milling
Modern Practice in Zinc Metallurgy
Electrostatic Ore Separation

THOMAS B. CROWE, Victor, Colo.
Superintendent New Portland Mill
The Metallurgy of Cripple Creek Ores

GEORGE E. COLLINS, Denver, Colo.
Mining Engineer
The Economics of Metal Mine Accidents

JOHN A. TRAYLOR, New York, N. Y.
President Traylor Engineering Works Co.
Jigs

L. S. PIERCE, Denver, Colo.
The Pierce Amalgamator

W. H. TRASK, Jr., Denver, Colo.
Central Colorado Power Co.
Hoisting

JOHN L. MALM, Denver, Colo.
Metallurgical Engineer
The Future of Chemical Engineering

JAMES M. McCLAVE, Denver, Colo.
Metallurgist
Ore Concentration

PHILIP ARGALL, Denver, Colo.
Consulting Metallurgist
The Flotation Process

HON. WAYNE C. WILLIAMS, Denver, Colo.
State Industrial Commission
The Colorado Workmen's Compensation Act

M. G. HODNETTE, Denver, Colo.
Union Central Life Insurance Co.

Safety and Conservation in Life Insurance

NEWCOMB CLEVELAND, Denver, Colo.
Ocean Accident and Guarantee Co.

The Insurance Angle of Our Workmen's Compensation Act

FRANK H. STORMS, Wellesley Hills, Mass.
Babson's Statistical Organization

Interpretation and Use of Financial Reports

H. S. SHELDON, Denver, Colo.
Vindicator Consolidated Gold Mining Co.

Gold Mining Camps in Colorado

JAMES H. PLATT, Toluca, Mexico
Mining Engineer

Mining Conditions in Mexico

DR. HENRY M. PAYNE, New York, N. Y.
Consulting Engineer Goldfields Consolidated Co.

Alaska Gold Placers
Siberian Gold Placers

FRED CARROLL, Denver, Colo.
State Commissioner of Mines

Oil Flotation of Ores

M. J. SHIELDS, M. D., Washington, D. C.
American Red Cross Society

First Aid to the Injured

JOHN W. AMESSE, M. D., Denver, Colo.

Diseases of Warm Climates

CHAUNCEY E. TENNANT, M. D., Denver, Colo.

First Aid to the Injured

DR. A. J. LANZA, Washington, D. C.
United States Bureau of Mines

Miner's Consumption

R. M. SHUMWAY, Denver, Colo.
Rocky Mountain Fuel Co.

Coal Deposits and Coal Mining in Colorado

The Campus

LOCATION AND DESCRIPTION, HISTORY, ORGANIZATION, AND FINANCIAL SUPPORT

LOCATION AND DESCRIPTION

The Colorado School of Mines is in the south central part of the City of Golden, Jefferson County, Colorado. It occupies a plat of approximately twenty-three acres, picturesquely situated about 200 feet above the bed of Clear Creek, at the base of the scenic front range which lies about fifty miles to the east of the main range of the Rocky Mountains. Farther east, about thirteen miles, lies the City of Denver which can be reached by three railway lines: the Denver and Intermountain Railroad, Arapahoe Street Station; the Denver and Northwestern Railway, Fifteenth Street Loop or Union Depot; or the Colorado & Southern Railway, Union Depot.

Golden has about three thousand inhabitants, and is one of the oldest cities in Colorado. The altitude is five thousand seven hundred feet above sea level, or about four hundred fifty feet above Denver. The climate is invigorating and bracing, with open winters and a large proportion of clear days.

The Colorado School of Mines is particularly fortunate in its natural surroundings and proximity to a rich, practical laboratory. The State of Colorado is famous for its basic industries, the mining of gold, silver, and the baser metals, all of which, together with their allied branches of industry, are highly developed within a relatively small area, of which every part is easily accessible from Golden. In addition, the vast vanadium, tungsten, uranium, and radium fields are better represented here than in any other part of the world. In view of its great number and variety of mining and metallurgical enterprises the State offers unexcelled opportunities for practical study.

The school is fortunately situated for the geologist. The surrounding formations not only present the strikingly clear features so characteristic of the West, but also occur in great profusion and variety. In addition, certain features peculiar to this locality afford sufficiently complicated problems to be of great value to the student of geology. It is possible, therefore, without going more than a mile or two from the school to illustrate effectively most geological problems so that field geology can be carried on at the same time with class instruction.

In the immediate vicinity of Golden are numerous clay mines which produce pottery clay and fire clay; also lime and stone quarries. Within a few miles are extensive coal mines well equipped with hoisting and power machinery; pyritic smelting works; and the sites of dredging and dry placer operations.

In Clear Creek Canon, a short distance west of Golden, are the historic mining camps of Central City, Black Hawk, Idaho Springs and Georgetown, where placer drift mining is carried on in the old river beds, and a great variety of lode mines and milling plants are in operation. The ores of this district vary from free-milling gold quartz to complex silver-lead-zinc ores.

Farther west is the camp of Breckenridge, where placer mining is carried on, and the small mining camps of Montezuma, Kokomo, and Robinson. To the southwest is the famous Leadville district, well known for its rich lead and zinc ores. West of Leadville is the once renowned silver mining camp of Aspen, and to the north of Leadville are the lead-zinc camps of Redcliffe and Gilman.

At the Globe plant of the American Smelting and Refining Company in Denver the treatment of lead ores and dry ores of gold and silver is illustrated. Here also the many mining and metallurgical machinery plants afford an excellent opportunity for the study of recent improvements in metallurgical design.

West of Colorado Springs are located the Portland, the Standard and the Golden Cycle Mills, which treat ore from the Cripple Creek district. Farther west are the prominent camps of Victor and Cripple Creek, in which are located some of the famous gold mines of the world. Near Victor are the well known Independence, the Portland, and the Ajax Mills, where low-grade Cripple Creek ores are successfully treated.

The plant of the Colorado Fuel and Iron Company, at Pueblo, possesses all the recently invented and approved devices for the production of iron and steel and for the working of these products into marketable forms. At Pueblo are located the Pueblo lead smeltery and the zinc smeltery of the Colorado Zinc Company. At Florence the Union Mill is located. At Canon City is the plant of the Empire Zinc Company. The Ohio and Colorado Smeltery is located at Salida, and the Arkansas Valley Smeltery at Leadville.

In the southwestern part of Colorado is the famous San Juan mining district, which includes the well known camps of Ouray, Telluride, Silverton, and Lake City, where many great mines are located and some of the most efficient milling plants in the world are to be found.

Coal mining is well represented in Colorado by the bituminous mines of the northern coal fields, the anthracite fields of

Glenwood Springs, the coal fields of Trinidad, and numerous smaller fields. Oil fields are being developed and operated at Florence and at Boulder.

Many prominent mining camps in neighboring states are easily reached from Golden. Among these are the great copper districts of Montana, Utah and Arizona, where the latest mining, milling, and smelting operations are in progress; the iron mines of Wyoming; and the gold mining camps of South Dakota.

No other mining school in the world has within easy access such a wide variety of mining properties, or such excellent opportunities for observing the latest and best milling and smelting operations.

HISTORY

The Colorado School of Mines was established by an act of the Territorial Legislature, approved February 9, 1874. Since that time the School has enjoyed a strong and steady growth in buildings, in equipment, in students, in faculty, and in the strength and rigor of its courses. Additions were made to the original building of 1880, by the building of 1882, and by the building of 1890, all of which are now united and called the Hall of Chemistry. The Hall of Physics was erected in 1894, the Assay Laboratory in 1900, and Stratton Hall in 1904. The Heating, Lighting, and Power Plant was completed in 1906. The Administration Building, named Simon Guggenheim Hall for the donor, was also erected in 1906. The Gymnasium was completed in 1908. The Experimental Ore Dressing and Metallurgical Building was completed in 1912.

ORGANIZATION

The corporate name of the institution is "The School of Mines." The general management of the School is vested by statute in a Board of Trustees, which consists of five members appointed by the Governor of the State, with the advice and consent of the Senate. The members of the Board of Trustees are appointed in alternating sets of two and three, and hold their office for a period of four years and until their successors are appointed and qualified. The Board of Trustees elects one of its members President. A Secretary and a Treasurer are appointed from the Board's number, or from without if deemed advisable. Any three of the Board of Trustees constitute a quorum for the transaction of business. The Constitution of Colorado recognizes the School of Mines as an Institution of the State.

FINANCIAL SUPPORT

The Colorado School of Mines is supported by the income derived from the annual tax of one-fifth of a mill on each dollar of the assessed valuation of the property in the state. This is known as the "School of Mines Tax." In addition to this, the legislature from time to time provides such special appropriations as the means of the state treasury permit and the necessities of the school suggest.

BUILDINGS

SIMON GUGGENHEIM HALL—Administration Building

This building, the gift of Senator Simon Guggenheim, was erected and furnished at a cost of $80,000. The corner-stone was laid by the A. F. and A. M. of Colorado, October 3, 1905. It is one hundred sixty-four feet long by fifty-seven feet wide and is surmounted by an ornate tower. The first floor is devoted entirely to the department of geology and mineralogy, and includes lecture room, laboratory, offices, two work rooms and a public museum; the second floor contains the library, the offices of the President, Secretary, and Registrar, the Faculty and Trustees' room; the third floor contains the Assembly Hall, two lecture rooms for mathematics, an office, and the Tau Beta Pi room. The building was dedicated October 17, 1906.

HALL OF CHEMISTRY

This is a continuous group of brick buildings which comprise the buildings of 1880, 1882, and 1890. The combined buildings of 1880 and 1882 contain the main chemical laboratories. In the building of 1890 are the office and laboratory of the professor of chemistry, the chemical lecture room, the museum of applied chemistry, three recitation rooms, the laboratories for gas and water analysis, and the freshman and sophomore drawing room.

ASSAY BUILDING

This building, forty-six by ninety-two feet, was built in 1900 with funds contributed by the late W. S. Stratton, and enlarged in 1905. The design and equipment of this building make it one of the best of its kind in the country.

GYMNASIUM

This building, costing $65,000, was completed in September, 1908. The first floor contains a large swimming pool, shower bath, and locker room, finished in white marble and tiling. There is also a room for boxing and wrestling. The second floor contains the offices of the athletic director, athletic board, and secretary of the Y. M. C. A.; and the Integral Club room. The entire third floor is occupied by the gymnasium room proper. This contains fifty-five hundred square feet of clear floor space and a balcony which provides accommodation for two hundred spectators.

HEATING, LIGHTING, AND POWER HOUSE

The power plant, erected at a cost of $40,000, is designed to furnish light, heat, and power to the entire school. It is a simple but artistic brick building, eighty-three by one hundred twenty-two feet, with concrete floors and cement roof. The building is divided lengthwise into an engine room thirty-four feet wide, and a boiler room forty-five feet wide. A conduit six feet wide and seven feet high surrounds the engine room below the floor and is used for steam and electric mains. A brick-lined steel stack one hundred twenty-five feet high carries all smoke to the upper air and away from the buildings.

STRATTON HALL

The corner-stone of this building was laid by the A. F. and A. M. of Colorado on November 20, 1902, and the building was completed in January, 1904. The basement wall and first story are of Lyons sandstone, in broken ashlar, topped by a story of gray Golden brick. The building is finished on the interior with red pressed brick. Little wood is used, except in the floors and staircases. The basement accommodates the metallurgical, strength of materials, and electrical laboratories. The first floor contains two large lecture rooms, each with apparatus room and private office. One-half of the second floor accommodates the surveying and mechanics in one large lecture room, with apparatus room and private office, and the other half contains a class room and the metallurgical research laboratory. The third floor is devoted entirely to a large drafting room for the junior and senior classes. The structure was named in honor of the late W. S. Stratton, who contributed $25,000 toward its cost.

THE EXPERIMENTAL ORE DRESSING AND METALLURGICAL BUILDING

This building, 100 by 150 feet, erected in 1912, was made possible by an appropriation of $75,000 by the legislature of Colorado. It is situated a short distance from the campus, on the bank of Clear Creek. It is intended to be not only a laboratory for the use of the students in ore dressing and metallurgy, but also a testing plant for the benefit of the mining industry. It is the largest and most complete plant of its kind in the United States.

RESIDENCE OF THE PRESIDENT

This is a brick building of two and one-half stories. It was built in 1888.

CARPENTER SHOP

This is well equipped for the special demands which are continually arising in a technical school. The work varies from ordinary repair work to the careful construction of special apparatus needed in the various laboratories.

MACHINE SHOP

This contains the necessary machinery for the maintenance and repair of equipment and also for the construction of such apparatus as is required for carrying on any new or original work.

LABORATORIES AND EQUIPMENT

The Experimental Ore Dressing and Metallurgical Plant

THE BUILDING

The experimental plant is situated on the bank of Clear Creek, a few blocks from the campus of the School. The building is 98 by 141 feet 8 inches on the ground floor. The framework is of structural steel resting on concrete foundations which have been carried down to a substantial bed of gravel. The walls consist of two and one-half inches of cement mortar, reinforced by "hy-rib," and are of natural cement color. The roof is of elaterite resting on a two-inch sheathing of matched Oregon fir. The ground floor is concrete and is divided into three benches. Above the ground floor, but covering only a part of the area, are two suspended floors of reinforced concrete, supported by steel framework. The building is well lighted and is properly ventilated.

POWER

All machinery and apparatus requiring power are operated by alternating current motors supplied with current from the power house. For the generation of the current required a producer-gas-power generator unit of 100 kv-a capacity has been installed in the power house. This unit is of Westinghouse design and consists of a bituminous suction gas producer, a vertical three-cylinder gas engine, and a direct-connected alternating current generator.

The producer has a number of noteworthy features. The principal one, and the one which contributes so largely to its success, consists of the two distinct fire zones. This feature makes it possible to operate successfully on very low-grade fuel, and eliminates the difficulties usually arising from the tar and hydrocarbons given off and deposited during the process of gas making. Ordinary Colorado lignite coal is used. From this is produced a cool, clean gas with a heat value of from 115 to 130 B. T. U. a cubic foot. To eliminate the loss of power on account of a reduced intake pressure, a motor-driven, positive-pressure type of exhauster is used. This draws the gas from the producer and delivers it to the engine at a pressure corresponding to about four inches of water.

The engine is of the standard Westinghouse vertical three-cylinder type, single acting, and using a four-stroke cycle. The

cylinders are 15 in. diam. by 14-inch stroke. At a speed of 257 revolutions per minute, the engine operating on the producer gas, delivers 118 b. h. p. Compressed air is used for starting, and both engine and producer can be started readily, even though they have stood idle for several days.

Direct-connected to the engine through a flanged coupling is a 100 kv-a. 2,300-volt, three-phase, 60-cycle generator. The current is transmitted at this voltage to the experimental plant where it is stepped down to the working voltage of 440. The installation is such that the 100 kv-a machine can be operated in parallel with a steam turbine in the power house. In case of an emergency all power can be supplied from the turbine alone.

SECTIONS

The plant, when fully equipped, will consist of four sections or units—sampling, concentration, cyanidation, and a fourth devoted to roasting and special apparatus, such as magnetic and electrostatic separators, dry tables, and flotation processes. The general equipment includes a Curtis air compressor, two motor-operated platform elevators giving control over all the floors, a Ruggles-Coles dryer, a revolving hearth roasting furnace, ore bins, track scales, turn tables, and ore cars.

The sampling section contains the following equipment: One Vezin sampler, one Brunton sampler, one portable feed hopper, one set of 12 by 20-inch Traylor rolls, with accessories for finishing the sample such as laboratory crusher and pulverizers, bucking board, and riffles.

The concentrating unit contains one 7 by 10-inch Blake crusher, one 2D Gates gyratory crusher, one set of 14 by 30-inch P. & M. M. rolls, one set of 12 by 24-inch P. & M. M. rolls, one 3½-foot Huntington mill and one 3½-foot Akron Chilean mill for regrinding, one Richards pulsator jig, one Joplin jig of one compartment, one all-iron Traylor jig of four compartments, one No. 6 Wilfley table, one Deister sand table, one Deister slime table, one Johnson vanner, one Richards pulsator classifier, one three-compartment classifier, two Callow cones, grizzilies, revolving screens, sampling devices and the necessary sand pumps, elevators, and concentrate driers. In addition, the concentrator contains a battery of five gravity stamps equipped with amalgamating plates and clean-up pan. A special feature of this unit is a small-sized apparatus for the handling of small ore lots; i. e., a Callow preliminary ore-testing plant, a quarter-size Wilfley table, and a quarter-size Card table. Through this arrangement, ore lots of any size whatever may be tested efficiently.

On the lower floor a six-cell flotation unit of ten tons capacity and an Oliver filter are installed. In addition, small equip-

ment, such as a chlorination barrel, Hendryx combined agitator and filter, and Hendryx agitator for hydrometallurgical treatment of copper ores, are available.

Concentrating tables, jigs, classifiers, and settling cones are so connected by a system of returns that tailing and concentrate can be reunited and returned to the feed troughs of the respective appliances. This feature enables the student to study the various adjustments possible to decided advantage.

The cyanide section contains one 4-foot tube mill, one 3½ by 10-foot Pachuca tank, one Paterson agitator, one Dorr classifier, one Butters filter, one six-compartment zinc box, one filter press for zinc slime, solution storage tanks, and a small pebble mill. This department is also provided with small-scale apparatus in the form of agitators and precipitating devices.

In the southeast corner of the plant a Huff electrostatic separator, a Wetherill separator, and a Dings double magnetic separator, together with accessory apparatus, are installed.

RESEARCH FEATURES

Besides supplying the students of the school with a splendid laboratory and thereby increasing the efficiency of their studies, the plant can be used as a research laboratory by the faculty and the alumni of the school. The plant is organized as a division of the metallurgical department.

COLLECTION OF COMMERCIAL ORES

Most collections of ores are classified according to their mineral contents, but the department of mining is pursuing the policy of gathering average ore samples from every mining district. These are arranged geographically so that the typical ores of each mining district are placed together. Such an arrangement is found to be of great educational value to the classes in mining. The collection now numbers about 1,250 specimens.

MINERALOGICAL AND GEOLOGICAL LABORATORY AND CABINET

Under the name cabinet is embraced not only the display collections, which may perhaps be called the cabinet proper, but also the other collections that have been prepared mainly for the purpose of class instruction. These collections are necessarily changing from year to year, as new material is constantly being added. This new material is obtained partly by purchase, but mainly by direct collecting, by gifts, and by means of exchange with other institutions. The display collections are not thoroughly classified, but are arranged in different cases with a view to displaying certain groups of minerals, or min-

erals from certain localities. The various collections, which together contain sixty-six thousand specimens, consist of display, type, and working or study collections of minerals, fossils, rocks, and ores. The rock collections include a general collection from different countries, one devoted to Colorado localities, and still others that cover particular countries or localities.

EXCHANGES

The School has prepared a printed list of exchange material, covering both minerals and rocks. The list will be sent to all who wish to arrange for exchanges. Correspondents should state what material they are prepared to offer in exchange. Letters should be addressed to Professor H. B. Patton, Golden, Colorado.

MINERALOGICAL LABORATORY

Aside from the special advantages due to location, the department of geology is admirably equipped for practical teaching. The entire first floor of Guggenheim Hall is occupied by this department. The south end of the building is occupied by a commodious lecture room, with a seating capacity of more than a hundred, and by a separate mineralogical laboratory with table space for between fifty and sixty students, also by two small recitation rooms. On the extreme north end of the building is the public museum, devoted to a display of fine minerals. Additional space is provided for working rooms, offices, packing, and storage rooms.

METALLURGICAL COLLECTIONS

The School has a fine collection of models from the works of Theodore Gersdorf, Freiberg, Saxony, which illustrate the best type of furnaces in this and other countries. Each model is made to scale and is complete in every detail. In addition to these models are the following to illustrate the best modern practice: Working model of a twenty-stamp mill, on a scale of one and one-half inches to the foot; working model of crushing rolls; working model of a Dodge crusher; model of modern blast furnace for lead-silver ores, with water jacket; smaller models, such as the complete set used in the famous Keyes and Arents lead-well suit. There is also a large collection of ores, ore dressing and metallurgical samples and products.

METALLURGICAL LABORATORY

This laboratory is equipped with apparatus for the study of the quantitative relations of the various agencies taking part in metallurgical changes. The Junker, the Mahler Bomb, and the Parr calorimeters, the Wanner optical, the Le Chatelier, and

Bristol electrical pyrometers, together with several electrical furnaces and a Hoskin gasoline furnace, are used for obtaining the desired temperature for experimentation. Desks and apparatus are provided for small-scale work in concentration, amalgamation, chlorination, and cyanidation. Ten separate flotation cells of the Minerals Separation Company's type and a Callow pneumatic cell, all power driven, are provided for the experimental work in the flotation process. The necessary chemical equipment for analyses is also provided. For the physical examination of ores and metallurgical products, five small dissecting, two Leitz, and one Bausch and Lomb compound metallographic microscopes are provided. The necessary standard screens are available. Provision for large scale work is made in the experimental ore dressing and metallurgical plant.

ASSAY LABORATORY

This laboratory is divided into parting, balance, furnace, storeroom, and office. It is equipped with thirty-two coal-fired muffle furnaces, seven Case distillate furnaces, one gasoline furnace, two Braun cupel machines, two Iler cupel machines, and two bullion rolls, one of which is of the Braun type. In order to avoid dust, change of temperature, and direct sunlight, the balance room has no outside walls, and is lighted by means of skylight. The equipment includes seven special pulp balances, five silver balances, three gold balances, one Thompson multiple rider balance, and one Mine & Smelter Supply Company button balance, Wilfred Heusser type, No. 1000, sensitive to 1-500 milligram. This variety is selected in order to acquaint the student with the various mechanisms and adjustments in assay balances. Each student has his own muffle, with his own coal bin, pulp balance, and desk, conveniently arranged with regard to his furnace; he has also access in the balance room to the best type of assay and pulp balances.

SURVEYING EQUIPMENT

The equipment of the department of surveying is well adapted to the practical course given. For transit work there are twenty-five light mountain transits, of which six are provided with solar attachments for determining the meridian and latitude, and eleven with auxiliary telescopes for underground work. There are also three heavy transits, one of which is of English and one of German make. In addition to the transits there are three plane tables for taking topography. For leveling, seven wye levels and five dumpy levels of standard manufacture are used. The department is well supplied with leveling rods of various makes and types, stadia rods, hand levels, clinometers, range poles, and other accessories. The instruments are

manufactured by such well known firms as C. L. Berger & Sons, Buff & Buff, Heller & Brightly, Eugene Dietzgen & Co., Peter Heer & Co., W. and L. E. Gurley, Keuffel & Esser, William Ainsworth & Sons, Weiss & Heitzler, Young & Sons, Negretti & Zambra (English), and Max Hildebrand (German).

CHEMICAL LABORATORIES

The freshman, sophomore, and junior laboratories accommodate two hundred and fifty students, and are equipped with especially designed tile-topped oak desks, provided with low reagent shelves, gas, water, filter pumps, and large porcelain sinks. The balance rooms are equipped with Sartorius, Becker, and Spoerhase balances. Gas is supplied to the building from a 300-light Detroit gas machine, which is connected with buried supply tanks outside the buildings. Good ventilation is obtained by means of two Sturtevant fans.

HYDRAULIC LABORATORY

The hydraulic laboratory contains weirs and orifice tanks for the determination of coefficients of discharge, calibrated tanks for water measurement, a steel pressure tank for artificial heads, pumps for water supply, and gages for pressure. A hydraulic ram is used to illustrate this class of apparatus and for testing. A long sheet-iron trough with a car over it is used for calibrating current meters. Water wheels and centrifugal pumps are tested for efficiency under various conditions of head and load. A swinging tank is used to measure jet reactions. Friction losses in pipes and elbows are measured. Hook gages are used for the accurate determination of low heads. Streams and ditches in the vicinity of Golden are gaged by means of the current meter, by rod floats, by slope, and by a Pitot tube. A two-inch Venturi meter and manometer set is used in measuring pipe flow.

PHYSICAL LABORATORIES

The physical laboratory is in the basement of the Chemistry Building. Adjoining the main laboratory is a balance and instrument room, and a dark room containing a complete Lummer-Brodhun photometer and an optical bench. The equipment is particularly adapted to the instruction of students of engineering, and is designed to teach the principles of elasticity and efficiency of machines, composition and resolution of forces, various forms of motion, density, velocity and pitch of sound, focal length of lenses, magnifying power, and the principles of the construction of telescopes. The heat equipment is particularly well adapted for calorimetry, heat expansion determinations, and for the determining of the mechanical equiva-

lent of heat. A complete line of galvanometers, standard resistances, condensers, ammeters, voltmeters, dynamometers, permeameters, standard cells, and a Kelvin balance compose the electrical apparatus; in magnetism all the principles which underlie the construction of magnets for lifting purposes and for the separation of ores are demonstrated in the laboratory.

TESTING LABORATORY

The laboratory is provided with a motor-driven 100,000-pound Riehle testing machine arranged for experiments in tension, compression, shearing, and flexure of materials of construction. Extensometers for measuring elongations and compressions are employed. Numerous steel sections provide useful problems in determining centers of gravity and moments of inertia.

The equipment for cement testing includes a 2,000-pound Riehle testing machine, and a 2,000-pound Olsen automatic shot cement-testing machine for testing briquettes in tension. Scales and volumeters are provided for measuring quantities in bulk. The specific gravity of cement is determined by means of Le Chatelier apparatus. A nest of fineness sieves and a set of very sensitive scales equip the student for the fineness test. Setting is determined by means of the complete Vicat apparatus. Trowels, spatulas, large slate-mixing boards, breakers, moulds, damp box, and immersing vats, provide apparatus for the making and setting of briquettes and for the soundness tests. Moulds are used for making cubes of concrete for compression tests. The use of reinforced concrete is illustrated by complete models of forms for the manufacture of reinforced concrete columns and beams, and by numerous samples of various types of reinforcing bars.

ELECTRICAL LABORATORY

This laboratory is equipped with standard voltmeters, ammeters, and wattmeters, inductive and non-inductive resistances for artificial loads, a Thomson apparatus for induction experiments, a slip indicator for induction motors, an automatic speed recorder which can be used for finding the acceleration curves of motors, an Alden absorption dynamometer for motor testing, a contact apparatus for alternating current and voltage wave form, a split phase rotary field apparatus, a 10,000-volt oil switch in a glass receptacle so that its action may be observed, a horn break cutout, tank and transformers used in insulator tests. The generators available for laboratory work include a 100 kv-a, 2,300 volt, 60 cycle, 3 phase Westinghouse alternator, driven by a Westinghouse producer gas engine, a 75 kw. 240 volt, 3 wire, d. c. Westinghouse generator, driven by a 112 h. p. 2,300 volt, 3 phase, synchronous motor, a 75 kw. Bullock twin

unit continuous current generator set, driven by a 110 h. p. De Laval turbine, a 30 kw. 1,100 volt, 125 cycle, single phase General Electric alternator, a 15 kw. 130 volt compound, continuous current generator designed and built at the school, an 8 kw. Crocker-Wheeler generator, a 6 kw. 130 volt Westinghouse generator, a 2 kw. 120 volt compound Brush machine, a series arc light machine, and a small Edison shunt generator. The Bullock generators can be connected at the switchboard to supply the 120-240 volt 3 wire lighting and power circuits, or they can be put in parallel and thus supply more than 600 amperes for electrothermic work. The motors include a 10 h. p. 220 volt, 60 cycle, 3 phase constant speed induction motor of General Electric make, two 5 h. p. series motors with controllers, a 5 h. p. 3 phase, two-speed induction motor, used for electric drilling, a 4 h. p. single-phase Wagner motor, a 400-2,000 rev. per min. adjustable speed experimental motor designed and built at the school, a 20 h. p. series motor, and a large number of 3 phase motors and shunt machines of standard makes in daily use about the shops and buildings. The storage batteries of 54 cells each are in daily use and are available for study. In addition to these generators and motors, a modern 5 panel d. c. switchboard and 7 panel a. c. and d. c. switchboard with the usual instruments, switches, and auxiliaries, afford excellent opportunities for the study of electric plant equipment. The engine room is utilized as a part of the dynamo laboratory, but the laboratory in Stratton Hall, equipped with numerous circuit outlets and portable instruments, is used chiefly for the study of motors and their auxiliaries.

MINING LABORATORY

The laboratory work in mining is carried on principally at the tunnel belonging to the school. The equipment here consists of numerous drills which are taken apart, reassembled, and used by the student; forges, anvils and tools for blacksmithing; the air receiver, valves, gages, fuses and switches connected with the compressed air and electric power transmission from the power plant; two mining cars; materials for track laying, and all other supplies usually found at a tunnel house. Among the makes of rock drills used by the students are Rand, Ingersoll, Sergeant, Leyner, McKiernan, Wood, Hardsocg, Shaw, Ingersoll-Leyner, Dreadnaught, Waugh, and Temple-Ingersoll. All of the mountings, such as bars, tripods, and arms, and a supply of drill steel, are also provided. For the measurement of air consumption in drilling operations, the Clark, Drillometer, and displacement meters are installed. Batteries, galvanometers, and rheostats are provided in connection with electric shot firing. In the laboratory at the school are two working size models of the Bleichert system of aerial trams; numerous models

of mines; an explosive tester; a collection of rock cores taken by diamond drills; models of timbering methods; many mine maps; instruments for measuring ventilation; lantern slides illustrating mining operations; samples of wire ropes and drill steels; lamps of the open and safety patterns; a dry placering machine; and many photographs of mines and operations.

LABORATORIES OF THE UNITED STATES BUREAU OF MINES

The laboratories and offices of the United States Bureau of Mines occupy practically all of the Engineering Building. These consist of two large general laboratories for analytical and research work on the second floor; a large laboratory for technologic experimental work in the basement; and in addition a number of small private laboratories and rooms for special work. The equipment is adapted to investigations in connection with the rare metals, both on a small and semi-commercial scale. The technologic laboratory is equipped with leaching apparatus of various kinds, precipitating tanks, filter presses, steam-jacketed kettles, roasting and fusing furnaces, etc.

The equipment for work in radioactivity is excellent, two rooms being especially reserved for this purpose. The Bureau possesses a considerable quantity of radium obtained in connection with its work with the National Radium Institute, which is reserved for research work.

MECHANICAL ENGINEERING LABORATORY

The heating, lighting, and power plant is well equipped for mechanical engineering laboratory practice. The boiler room contains the following principal equipment: One 200 h. p. and one 100 h. p. Babcock & Wilcox water tube boilers, each equipped with a chain grate; one 80 h. p. tubular boiler equipped with plain grate; Green Engineering Company fuel economizers; Babcock & Wilcox independently fired super-heater; Webster feed-water heater, boiler feed and vacuum pumps and injectors; one Wilcox water weigher; a 125 by 5-foot self-supporting steel stack supplemented by a steam-driven 42-inch Sirocco fan for induced draft; eight 25-ton steel bunkers for coal storage; and a 125 h. p. Westinghouse double-flow gas producer equipped with wet and dry scrubbers, mixing and gas storage tank, and motor-driven exhauster.

The engine room contains the following principal apparatus: 10 by 12-inch high speed Russell engine; 6 by 9-inch throttling Sturtevant engine; 75 kw. De Laval steam turbine geared to twin generators; 7 by 6-inch two-cylinder vertical Westinghouse Jr. engine; 15 by 14-inch three-cylinder vertical Westinghouse gas engine direct connected to alternator; 6¾ by 14-inch single

Fairbanks, Morse & Company gas engine; 8¾ by 14-inch Priestman oil engine; a J. George Leyner Engineering Works two-stage air compressor, capacity 275 cubic feet of free air per minute; and a small Westinghouse air-brake.

The laboratory is well equipped with auxiliary apparatus such as indicators, prony brakes, Orsat apparatus, calorimeters, manometers, etc., for conducting experimental work.

DRAWING ROOMS

Freshman and Sophomore This occupies the upper floor of the Hall of Chemistry. The floor area is about four thousand square feet. It is lighted by windows on the north, east, and west, and by eight large skylights in the roof. A suitable office for the instructors is in a central position, in which all drawings are filed and all records are kept. Each student is provided with a drawing table, a drawer, a drawing board, and a stool. The present equipment accommodates about one hundred fifty students. There are many models to aid the students in their work.

Junior and Senior The entire third floor of Stratton Hall is used for the junior and senior drawings. The room is 90 by 60 feet, lighted by windows and a large skylight. Each student is provided with a drawing table, a drawer, a drawing board, and a stool. Most of the drawing tables are independent and adjustable. The room has recently been equipped with especially constructed tables for the advanced work of the seniors. The present equipment accommodates about one hundred sixty students. There is a blut-print room fully equipped with an adjustable printing frame and all other necessary appliances. In one corner of the room is the office of the instructors, where all drawings and records are filed. There are for the use of the students a complete set of trade catalogues and a large number of blue prints from industrial corporations. These are kept up to date. One-half of the second floor of Stratton Hall is used as a drawing room for the senior class.

REQUIREMENTS FOR ENTRANCE

FRESHMAN CLASS

Unit Course A unit course of study is defined as a course covering a school year of not less than thirty-six weeks, with five weekly periods of at least forty-five minutes each.

Fifteen Units are required for entrance, of which twelve are specified and three may be chosen from a list of electives.

Specified Units

Essentials of Algebra	1	unit
Advanced Algebra	½	unit
Plane Geometry	1	unit
Solid Geometry	½	unit
Languages, other than English	2	units
English	3	units
History	2	units
Physics	1	unit
Chemistry	1	unit
Specified Units	12	
Elective Units	3	
Total Units for Entrance	15	

Elective Units

The three elective units may be selected from the following list: Drawing, Shop Work, Mathematics, Latin, Greek, French, German, Spanish, History, English, Science, Psychology, Political Economy. In allowing credit for drawing and shop work two forty-five minute periods will be regarded as equivalent to one forty-five minute period of classroom work. Half units are accepted in all studies except in physics and chemistry, provided that not less than one full unit shall be accepted in language.

Entrance

(a) By Certificate

A graduate of an accredited high school in the State of Colorado will be admitted without examination upon the presentation of proper credentials from the principal of his high school, provided that the studies he has completed successfully cover the requirements for entrance. Blanks for this purpose will be sent, on application to the president.

Graduates of accredited high schools in other states will be accepted in the same manner as graduates of accredited high schools in Colorado.

(b) By Examination

All other candidates for admission will be required to pass entrance examinations. These examinations are held in Golden.

For the benefit of any student who cannot take the examination in Golden, conveniently, on account of the distance, arrangements will be made so that he may take the examination under the direction of some responsible person at his own home, or near it.

Entrance examinations for the class of 1921 will be held in Golden on Wednesday, Thursday and Friday, August 29, 30, and 31, 1917.

Entrance examinations for the class of 1922 will be held in Golden on Wednesday, Thursday and Friday, August 28, 29, and 30, 1918.

It is the opinion of the Faculty of the Colorado School ot Mines that every candidate for the freshman class should have taken a thorough course of at least four years in a good high school, or its equivalent, and during the last year of his preparation should have had a thorough review of mathematics. Special attention should be given to the preparation in chemistry and physics.

If a first year student is found to be deficient in any of the subjects required for entrance, the faculty reserves the right to require such student to remove his deficiency before proceeding with his regular work.

REGISTRATION

The first Monday and Tuesday of September are the registration days for the first semester; and the first day of the second semester is the registration day for that semester. A fine of five dollars will be imposed for registration on dates later than those set aside for registration. This fine shall not apply to the initial registration of a student. The second Monday after registration is the latest date on which any student may register in the school for first semester work.

DESCRIPTION OF THE UNITS REQUIRED FOR ENTRANCE

ENGLISH (3 Units)

(a) **Grammar** The student should have a sufficient knowledge of English grammar to enable him to point out the syntactical structure of any sentence which he meets in the prescribed reading. He should also be able to state intelligently the leading grammatical principles when he is called upon to do so.

(b) **Reading** The books prescribed by the Joint Committee on Uniform Entrance Requirements in English form the basis for this part of the work.

The list is divided into two parts: the first consists of books to be read with attention to their contents rather than to their form; the second consists of books to be studied thoroughly and minutely.

The lists thus divided are as follows:

I Books prescribed for reading

Group I (Two to be selected)

Shakespeare's *As You Like It, Henry V, Julius Caesar, The Merchant of Venice, Twelfth Night*

Group II (One to be selected)

Bacon's *Essays;* Irving's *Life of Washington; The Sir Roger de Coverley Papers* in *The Spectator; Franklin's Autobiography*

Group III (One to be selected)

Chaucer's *Prologue;* Spencer's *Faerie Queene* (selections); Pope's *The Rape of the Lock;* Goldsmith's *The Deserted Village;* Palgrave's *Golden Treasury (First Series), Books II and III,* with especial attention to Dryden, Collins, Gray, Cowper and Burns

Group IV (Two to be selected)

Goldsmith's *The Vicar of Wakefield;* Scott's *Ivanhoe;* Scott's *Quentin Durward;* Hawthorne's *The House of the Seven Gables;* Thackeray's *Vanity Fair;* Mrs. Gaskell's *Cranford;* Dickens' *A Tale of Two Cities;* George Eliot's *Silas Marner;* Blackmore's *Lorna Doone*

Group V (Two to be selected)

Irving's *Sketch Book;* Lamb's *Essays of Elia;* De Quincey's *Joan of Arc* and *The English Mail Coach;* Carlyle's *Heroes and Hero Worship;* Emerson's *Essays;* Ruskin's *Sesame and Lilies*

Group VI (Two to be selected)

Coleridge's *The Ancient Mariner;* Scott's *The Lady of the Lake;* Byron's *Mazeppa* and *The Prisoner of Chillon;* Palgrave's *Golden Treasury (First Series), Book IV,* with especial attention to Wordsworth, Keats and Shelley; Macaulay's *Lays of Ancient Rome;* Poe's *Poems;* Lowell's *The Vision of Sir Launfal;* Arnold's *Sohrab and Rustum;* Longfellow's *Evangeline;* Tennyson's *Gareth and Lynette, Lancelot and Elaine,* and *The Passing of Arthur;* Browning's *Cavalier Tunes, The Lost Leader, How They Brought the Good News from Ghent to Aix, Evelyn Hope, Home Thoughts from Abroad, Home Thoughts from the Sea, Incident of the French Camp, The Boy and the Angel, One Word More, Herve Riel, Pheidippides*

II Books prescribed for study and practice

Shakespeare's *Macbeth,* Milton's *Lycidas, Comus, L'Allegro,* and *Il Penseroso;* Burke's *Speech on Conciliation with America*

or Washington's *Farewell Address* and Webster's *First Bunker Hill Oration;* Macaulay's *Life of Johnson*, or Carlyle's *Essay on Burns.*

(c) **Composition** Regular and persistent training in both written and oral composition should be given throughout the entire school course. The topics should be so chosen as to give practice in the four leading types of prose discourse, namely, description, narration, exposition, and argument.

(d) **Rhetoric** The instruction in this subject should include the following particulars: Choice of words, structure of sentences and paragraphs, the principles of narration, description, exposition and argument.

The teacher should distinguish between those parts of rhetorical theory which are retained in text books merely through the influence of tradition and those which have a direct bearing upon the composition work. The former may be safely omitted.

HISTORY (2 Units)

Any two of the following periods may be offered:

I Ancient History, with special reference to Greek and Roman History, with a short introductory study of the more ancient nations and the chief events of the early middle ages, down to the death of Charlemagne

II Mediaeval and Modern European History, from the death of Charlemagne to the present time

III English History

IV American History, or American History and Civil Government

MATHEMATICS (3 Units)

The courses offered by the school are so exacting that a thorough training in the following prerequisites is essential. Students found deficient in any of these subjects will be assigned to special classes, provided by the school, to remove such deficiencies in addition to the regular freshman work in mathematics, and in no case will a student be permitted to proceed with the full freshman schedule if he be judged deficient in algebra and solid geometry. The regular courses are so arranged that an ambitious student with mathematical tendencies, even though compelled to enlist in such extra work, may complete the entire freshman schedule in mathematics before the beginning of the sophomore year.

I **Essentials of Algebra** (1 Unit) The four fundamental operations for rational algebraic expressions; factoring; complex fractions; the solution of equations of the first degree containing one or more unknown quantities; radicals; theory of indices; quadratic equations and equations containing one or more un-

known quantities that can be solved by the methods of quadratic equations; problems dependent on such equations.

II **Advanced Algebra** (½ Unit) This course should begin with a thorough review of the essentials. Later work should cover an introduction to the graphical representation of linear and simple quadratic expressions; ratio and proportion; variation; binomial theorem; the progressions; and logarithms.

III **Plane Geometry** (1 Unit) Completed, with the solution of original exercises and numerical problems.

IV **Solid Geometry** (½ Unit) Properties of straight lines and planes; of dihedral and polyhedral angles; of projection; of polyhedrons, including prisms; of pyramids and the regular solids; of cylinders, cones and spheres; of spherical triangles, and the mensuration of surfaces and solids.

CHEMISTRY (1 Unit)

The equivalent of Brownlee's **Elementary Chemistry,** Bradbury's **Elementary Chemistry** or Remsen's **Briefer Course of Inorganic Chemistry,** with experiments.

PHYSICS (1 Unit)

The equivalent of Carhart and Chute's **High School Physics,** or Gage's **Principles of Physics,** together with systematic laboratory practice such as is outlined in Crew and Tatnall's **Laboratory Manual in Physics.**

The two units required in languages other than English may be offered in Greek, Latin, French, German, or Spanish.

ADMISSION TO ADVANCED STANDING

Applicants who are graduates of technical or scientific schools or colleges of good standing will be admitted without examination upon the presentation of proper credentials. They will be permitted to take any subject taught in connection with the regular courses, provided, in the opinion of the instructor, their previous experience and training will enahle them to pursue the subject with profit. Each case will be judged on its own merits, but applicants will be advised to become candidates for a degree and to complete one of the regular courses of the school.

Applicants who have partly completed the course in technical or scientific schools or colleges of good standing will be admitted without examination upon the presentation of proper credentials. Due credit will be allowed for the successful completion of work which is equivalent to that given in the Colorado School of Mines. Plates of drawings, laboratory note books, and catalogues of the institution attended, should be submitted with applications for advanced standing. All credits given to ad-

vanced standing students are given provisionally, with the understanding that such credits may be withdrawn at any time in case a student fails to maintain a creditable standing. Application blanks will be furnished, on request to the president.

DEGREES

The degree of E. M. (Engineer of Mines) will be conferred upon a candidate who fulfills the following conditions:

(a) He must complete the prescribed work of the freshman, sophomore, junior, and senior years.

(b) He must complete enough additional elective work to make a total of one hundred credit hours of junior and senior grade.

A student admitted to advanced standing from another institution, in order to become a candidate for the degree Engineer of Mines, must have completed satisfactorily a minimum of fifty credit hours in residence.

No diploma will be delivered until the full requirements of the course of study are satisfied, and all accounts with the school are settled.

The degree of M. S. (Master of Science) may be conferred upon a candidate who already holds a degree from this school or similar institution of good standing, and whose application for such degree shall have been approved by the faculty; provided, that the candidate completes work equivalent to fifty credit hours, chosen with the approval of the faculty, and presents an acceptable thesis. Before being accepted as a candidate the applicant must file with the Secretary of the Faculty a record of his previous attainments.

DEPARTMENTS OF INSTRUCTION

COURSES OF INSTRUCTION

TABULAR VIEW

FRESHMAN YEAR

FIRST SEMESTER	Page	Course No.	Lect. Hrs.	Lab. Hrs.
General Geology	68	51	3	
Engineering Drawing	82	127		9
General Chemistry	88	151	5	
Qualitative Analysis	89	153	1	3
College Algebra	97	205	3	
Plane Trigonometry	98	207	2	3
English	105	227	2	
Spanish	107	231	2	
Physical Training	121			
Total			18	15

SECOND SEMESTER	Page	Course No.	Lect. Hrs.	Lab. Hrs.
General Geology	68	52	2	
Plane Surveying	74	76	1	
Descriptive Geometry	82	128	2	6
General Chemistry	88	152	4	
Qualitative Analysis	90	154	1	8
Spherical Trigonometry	98	208	1	3
Analytic Geometry	99	212	4	
English	105	228	1	
Spanish	107	232	2	
Physical Training	121			
Total			18	17

Plane Surveying: Course 76a, p. 74, credit 5 hours; six weeks in the summer following the freshman year.

TABULAR YEAR

SOPHOMORE YEAR

FIRST SEMESTER	Page	Course No.	Lect. Hrs.	Lab. Hrs.
Mineral Land Surveying	53	1	1	
Crystallography	68	53	2	6
Machine Design	83	129	2	3
Quantitative Analysis	90	155	1	9
Physics	94	177	5	4
Calculus	100	213	5	
English	105	229	2	
Physical Training	121			
Total			18	22

SECOND SEMESTER	Page	Course No.	Lect. Hrs.	Lab. Hrs.
Mine Surveying	54	2	1	
Mineralogy	69	54	2	6
Machine Design	83	130	2	3
Quantitative Analysis	91	156	1	6
Physics	95	178	5	4
Calculus	100	214	5	
English	106	230	1	
Physical Training	121			
Total			17	19

Mineral Land Surveying: Course 1a, p. 53, credit 1 hour; two weeks in the summer following the sophomore year.

Mine Surveying: Course 2a, p. 55, credit 2 hours; two weeks in the summer following the sophomore year.

Mining Laboratory: Course 1b, p. 54, credit 2 hours; two weeks in the summer following the sophomore year.

TABULAR VIEW

JUNIOR YEAR

FIRST SEMESTER	Page	Course No.	Lect. Hrs.	Lab. Hrs.
Placer Mining	55	5	2	
Mine Accounting	56	7	1	
General Metallurgy	63	25	2	
Assaying	63	27	1	6
Historical Geology	70	55	3	3
Mechanics	75	77	5	
Direct Currents	79	101	3	3
Safety Engineering	109	251	1	
Total			18	12

SECOND SEMESTER	Page	Course No.	Lect. Hrs.	Lab. Hrs.
Mining Corporations	58	12	1	
Metallurgy of Iron and Steel	64	28	2	
Metallurgy of Lead	64	30	2	
Metallurgy of Zinc	64	32	2	
Lithology	70	56	2	3
Mechanics	75	78	3	
Testing Laboratory	76	80		3
Alternating Currents	79	102	3	6
Heat Engines	84	132	2	6
Safety Engineering	109	252	1	
Total			18	18

Field Geology: Course 68a, p. 72, credit 3 hours; four weeks in the summer following the junior year.

TABULAR YEAR

SENIOR YEAR

FIRST SEMESTER	Page	Course No.	Lect. Hrs.	Lab. Hrs.
Metal Mining	56	9	2	
Coal Mining	58	13	1	
Mine Valuation	59	15	2	
Mining Law	62	21	1	
Ore Dressing	64	33	4	3
Economic Geology	71	63	2	
Hydraulics	76	83	2	3
Compressed Air and Pumps	85	133	3	
Steam Laboratory	86	135		3
Safety Engineering	109	253	1	3
Total			18	12

SECOND SEMESTER	Page	Course No	Lect. Hrs.	Lab. Hrs.
Metal Mining	57	10	2	
Coal Mining	59	14	2	
Economics of Mining	60	16	1	
Mine Management	60	18	1	
Mine Valuation	62	22		3
Metallurgy of Gold and Silver	65	36	3	3
Metallurgy of Copper	65	38	2	
Electrometallurgy	66	40	2	3
Economic Geology	71	64	3	
Power Plant Design	85	134	2	6
Safety Engineering	110	254	1	3
Total			19	18

FIVE YEAR COURSE

Students who find the foregoing arrangement of courses too exacting and concentrated for satisfactory completion within the prescribed period of four years, and those who plan to take an active part in athletics, are advised to distribute their courses of study over a period of five years, as suggested in the following tabular view.

Students who elect to take the five-year course are required to schedule courses of study equivalent to not less than eighteen credit hours during each semester.

TABULAR VIEW

FIRST YEAR

FIRST SEMESTER	Page	Course No.	Lect. Hrs.	Lab. Hrs.
General Geology	68	51	3	
Engineering Drawing	82	127		9
General Chemistry	88	151	5	
Qualitative Analysis	89	153	1	3
Advanced Algebra	97	201	3	
Solid Geometry	97	203	3	
English	105	227	2	
Physical Training	121			
Total			17	12

SECOND SEMESTER	Page	Course No.	Lect. Hrs.	Lab. Hrs.
General Geology	68	52	2	
Descriptive Geometry	82	128	2	6
General Chemistry	88	152	4	
Qualitative Analysis	90	154	1	8
College Algebra	98	206	3	
Plane & Spherical Trigonometry	99	210	3	5
English	105	228	1	
Physical Training	121			
Total			16	19

SECOND YEAR

FIRST SEMESTER	Page	Course No.	Lect. Hrs.	Lab. Hrs.
Mine Accounting	56	7	1	
Crystallography	68	53	2	
Machine Design	83	129	2	3
Quantitative Analysis	90	155	1	9
Industrial Chemistry (Elective)	92	157	2	
English	105	229	2	
Spanish	107	231	2	
Physical Training	121			
Total			12	18

SECOND SEMESTER	Page	Course No.	Lect. Hrs.	Lab. Hrs.
Mineralogy	69	54	2	6
Plane Surveying	74	76	1	
Electric Shop	81	109		3
Machine Design	83	130	2	3
Quantitative Analysis	91	156	1	6
Industrial Chemistry (Elective)	92	158	2	
Analytic Geometry	99	212	4	
English	106	230	1	
Spanish	107	232	2	
Physical Training	121			
Total			15	18

Plane Surveying: Course 76a, p. 74, credit 5 hours; six weeks in the summer following the second year.

THIRD YEAR

FIRST SEMESTER	Page	Course No.	Lect. Hrs.	Lab. Hrs.
Mineral Land Surveying	53	1	1	
General Metallurgy	63	25	2	
Assaying	63	27	1	6
Historical Geology	70	55	3	3
Physics	94	177	5	4
Calculus	100	213	5	
Total			17	13

SECOND SEMESTER	Page	Course No.	Lect. Hrs.	Lab. Hrs.
Mine Surveying	54	2	1	
General Metallurgy (Elective)	63	26		3
Metallurgy of Iron and Steel	64	28	2	
Lithology	70	56	2	3
Heat Engines	84	132	2	6
Physics	95	178	5	4
Calculus	100	214	5	
Total			17	16

Mineral Land Surveying: Course 1a, p. 53, credit 1 hour; two weeks in the summer following the third year.

Mine Surveying: Course 2a, p. 55, credit 2 hours; two weeks in the summer following the third year.

Mining Laboratory: Course 1b, p. 54, credit 2 hours; two weeks in the summer following the third year.

FOURTH YEAR

FIRST SEMESTER	Page	Course No.	Lect. Hrs.	Lab. Hrs.
Placer Mining	55	5	2	
Coal Mining	58	13	1	
Mining Law	62	21	1	
Mechanics	75	77	5	
Direct Currents	79	101	3	3
Compressed Air and Pumps	85	133	3	
Steam Laboratory	86	135		3
Astronomy	103	221	2	
Safety Engineering	109	253	1	3
Total			18	9

SECOND SEMESTER	Page	Course No.	Lect. Hrs.	Lab. Hrs.
Mining Corporations	58	12	1	
Coal Mining	59	14	2	
Metallurgy of Lead	64	30	2	
Metallurgy of Zinc	64	32	2	
Mechanics	75	78	3	
Testing Laboratory	76	80		3
Alternating Currents	79	102	3	6
Astronomy	103	222	2	
Safety Engineering	110	254	1	3
Total			16	12

Field Geology: Course 68a, p. 72, credit 3 hours; four weeks in the summer following the fourth year.

FIFTH YEAR

FIRST SEMESTER	Page	Course No.	Lect. Hrs.	Lab. Hrs.
Metal Mining	56	9	2	
Mine Valuation	59	15	2	
Mine Equipment (Elective)	61	19	1	
Ore Dressing	64	33	4	3
Economic Geology	71	63	2	
Hydraulics	76	83	2	3
Electricity Applied to Mining (Elective)	80	105	3	3
Safety Engineering	109	251	1	
Total			17	9

SECOND SEMESTER	Page	Course No.	Lect. Hrs.	Lab. Hrs.
Metal Mining	57	10	2	
Economics of Mining	60	16	1	
Mine Management	60	18	1	
Mine Valuation	62	22		3
Metallurgy of Gold and Silver	65	36	3	3
Metallurgy of Copper	65	38	2	
Electrometallurgy	66	40	2	3
Economic Geology	71	64	3	
Power Plant Design	85	134	2	6
Safety Engineering	109	252	1	
Total			17	15

FEES

Fees are charged to cover depreciation, necessary repairs, maintenance, and renewal of permanent apparatus, materials destroyed and not returnable, power, gas, and other similar items; **and are payable strictly in advance at the beginning of each semester.** No part of a fee is returnable.

Exclusive of the tuition fee, paid only by non-residents of the State of Colorado, the entire fee expense for four years is $172.00, or an average of $43.00 a year. The matriculation fee is paid once. Each student in mineralogy is required to have his own blow-pipe outfit, the cost of which is estimated at $9.00, and his own magnifying glass, the cost of which is about $2.00.

The athletic fee, although collected by the school, is turned over to the Treasurer of the Athletic Association, and is expended only for athletic purposes.

YEAR	Freshman		Sophomore		Junior		Senior	
SEMESTER	1	2	1	2	1	2	1	2
Matriculation	$ 5.00	.....	.....	.....	.....	.....	.....	.....
Tuition	75.00	$75.00	$75.00	$75.00	$75.00	$75.00	$75.00	$ 75.00
Athletic	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Chemistry	7.00	7.00	7.00	7.00	.....	.....	.....	.....
Plane Surveying	.....	5.00	.....	.....	.....	.....	.....	.....
Crystallography	.....	.....	3.00	.....	.....	.....	.....	.....
Physics	.....	.....	4.00	4.00	.....	.....	.....	.....
Mineralogy	.....	.....	.....	6.00	.....	.....	.....	.....
Mineral Land Surveying	.....	.....	.....	3.00	.....	.....	...	.....
Mine Surveying	.....	.....	.....	3.00	.....	.....	.....	.....
Tunnel Work	.....	.....	.....	5.00	.....	.....	.....	.....
Assaying	.....	.....	.....	.....	10.00	.....	.....	.....
Electrical Laboratory	.....	.....	.....	.....	5.00	5.00	.....	.....
Testing Laboratory	.....	.....	.....	.....	.....	2.00	.....	.....
Lithology	.....	.....	.....	.....	.....	3.00	.....	.....
Field Geology	.....	.....	.....	.....	.....	5.00	.....	.....
Hydraulic Laboratory	.....	.....	.....	.....	.....	.....	1.00	.....
Steam Laboratory	.....	.....	.....	.....	.....	.....	5.00	.....
Safety Engineering	.....	.....	.....	.....	.....	.....	5.00	5.00
Ore Dressing	.....	.....	.....	.....	.....	.....	5.00	5.00
Electrometallurgy	.....	.....	.....	.....	.....	.....	.....	5.00
Graduation	.....	.....	.....	.....	.....	.....	.....	5.00
Total	$92.00	$92.00	$94.00	$108.00	$ 95.00	$ 95.00	$96.00	$100.00
Exclusive of Tuition	17.00	17.00	19.00	33.00	20.00	20.00	21.00	25.00

Fees for elective laboratory courses will be arranged with the professor in charge.

DEPOSITS

Deposits are required to cover the cost of apparatus and supplies issued to individual students and returnable if in good condition. The unused portion of the deposit is refunded.

Assaying	$25.00
Chemistry	10.00
Drawing	2.50
Locker	1.00

MINING

Harry John Wolf, Professor
Ralph Roy Knowles, Instructor

1 MINERAL LAND SURVEYING Lectures

Credit one hour

This course covers instruction in the methods of acquiring title to mineral lands in the United States and in foreign countries. Special attention is given to practice in the western United States. Determination of Meridian and Latitude by solar and stellar observation is explained. Methods of sub-dividing the public lands and the regulation of land offices and Surveyors General are discussed and explained. Instruction is given in the preparation and filing of the documents used in acquiring title to lode and placer claims; mill and tunnel sites; timber, coal and stone lands; water rights; dam and reservoir sites; and ditch, flume and pipe lines. The duties of the United States Deputy Mineral Surveyors are explained and the student is familiarized with the field methods and office practice involved in obtaining United States Patent to mineral lands. This course makes the student competent to pass the examination given by the Surveyor General to applicants for commissions as mineral surveyors.

Prerequisites: Courses 76 and 76a

References: Underhill, Mineral Land Surveying
Hodgman, Land Surveying
General Land Office, Manual of Instructions for the Survey of the Mineral Lands of the United States

One hour a week during the first semester of the sophomore year. (Wolf)

1a MINERAL LAND SURVEYING Field Work and Mapping

Credit one hour

This course co-ordinates with Course 1, Mineral Land Surveying, and embraces practice in laying out mining claims on the ground. The students are organized in suitable squads for efficient work in the field. Each squad is required to survey a lode claim, placer claim, mill site, and tunnel site; locate and mark all corners, as required by law in the case of an actual survey; tie the surveys to proper section corners, or other

monuments, and obtain all field data required for the calculation of intersections with conflicting claims; perform all office work required in connection with the surveys, including preparation of plate, field notes, and reports required by Land Office Directors and Surveyors General. These surveys are made in the mountains and foothills near Golden.

Prerequisite: Course 1, Mineral Land Surveying

References: Underhill, **Mineral Land Surveying**
General Land Office, **Manual of Instructions for the Survey of the Mineral Lands of the United States**
Field Notes
Plats

Two weeks in the summer following the close of the sophomore year. (Wolf)

1b MINING LABORATORY

Credit two hours

The work in this course is performed in a mine located on Mt. Zion, about three-quarters of a mile from the campus, where the school has built and equipped a mine shop and has driven a 7 by 8-foot adit. The shop is equipped with a forge and tools for blacksmithing, timbering, track-laying, piping and repair work; also drill steel, machine drills, mine cars, and other apparatus used in the underground work. The students work in squads of three or four and perform all of the usual duties involved in the driving of a tunnel, such as track-laying, timbering, drilling by hand and with machine drills, blasting, mucking, and tramming. Under the instruction of a practical miner the students learn to temper and sharpen their own steel to suit the varying conditions of ground and for the different makes of drills. Opportunity is afforded students to do extra work investigating the efficiency and power consumption of different makes of drills and the relative advantages of various brands of high explosives.

Two weeks in the summer following the close of the sophomore year. (Knowles)

2 MINE SURVEYING Lectures

Credit one hour

This course includes the theory involved in mine surveying. Among the subjects discussed are the following: The adjustment and uses of top and side telescopes and other transit accessories used in underground work; surface and underground surveys and traverses; carrying the meridian underground; underground connections; plumbing vertical shafts; determination of dip, strike and thickness of mineral deposits from results

of development, including drill-hole data; survey and measurement of stopes, rooms and pits; methods of recording surveys in field books and office records; methods of mapping, including plans, elevations, and sections of underground workings, and the design and uses of mine models.

Prerequisites: Courses 76 and 76a, Plane Surveying

References: Trumbull, **Manual of Underground Surveying**
Durham, **Mine Surveying**
Brough, **Mine Surveying**
Shurick, **Coal Mine Surveying**

One hour a week during the second semester of the sophomore year. (Wolf)

2a MINE SURVEYING Field Work and Mapping

Credit two hours

The practice in surface and underground work is given in one of the neighboring mining districts where typical mines are selected which provide a variety of problems common to mine surveying, such as shaft plumbing; adit and drift traversing; and making connections through shafts, tunnels, drifts, raises, winzes, and stopes. The student receives practice and acquires skill in the use of instruments, the taking of measurements, and the securing of important data under the numerous disadvantages and disagreeable conditions common to underground work. The location of water rights and the surveying of ditches, flumes, pipelines, and aerial tramways are included in this course. The students are organized in suitable squads for efficient field work and the members of each squad rotate so that each receives practice in a variety of duties. Students are required to make accurate maps of all surveys.

Prerequisite: Course 2

References: **Field Notes**
Mine Maps

Two weeks in the summer following the close of the sophomore year. (Wolf)

5 PLACER MINING Lectures

Credit two hours

This course covers the theory and practice involved in the recovery of precious metals from sand and gravel deposits. Among the subjects discussed are: panning, rocking, sluicing; methods of extracting gravel for sluicing; hydraulicing; drift mining; dry placering; dredges and their operation; thawing frozen ground. Typical operations are considered in detail, and

special attention is paid to capacity of machinery and operating costs.

References: Longridge, **Hydraulic Mining**
Longridge, **Gold and Tin Dredging**
Wilson, **Hydraulic and Placer Mining**
Weatherbee, **Dredging for Gold in California**
Aubury, **Gold Dredging in California**

Two hours a week during the first semester of the junior year. (Wolf)

7 MINE ACOUNTING Lectures

Credit one hour

This course begins with the fundamental principles of bookkeeping. The student is taught how to use the various books, records, and blanks involved in standard systems of accounting. The course is designed to impart a clear knowledge of double entry bookkeeping. Special attention is given to systems employed in dealing with the accounts of mining corporations, classification of mine, mill and smeltery accounts and the distribution of mining expenditures. The student is taught how to analyze costs, compile an operating statement, take off a trial balance, and prepare a financial report. Each student is required to enter in a set of blank forms the transactions covering a month's operations of a mining company.

References: Carlton, **American Mine Accounting**
Lawn, **Mine Accounts and Mine Bookkeeping**
Greendlinger, **Accounting Theory and Practice**
Wallace, **Simple Mine Accounting**
Wolf, **Notes on Mine Accounting**

One hour a week during the first semester of the junior year. (Wolf)

9 METAL MINING Lectures

Credit two hours

This course begins with a discussion of surface prospecting in various countries, the methods employed and the equipment required; and prospecting for ore, oil, and water by means of churn drilling and core drilling. Next, the methods of opening and developing the different types of mineral deposits are considered and compared. The various methods of excavating earth and rock are discussed and the different tools employed are described. Shaft sinking and tunnel driving are described, and the different systems of stoping are explained. The course includes the consideration of mine timbering; the kinds and properties of timber, and special methods of framing; methods of supporting vein walls with ore and waste filling; hand and

machine drills and drilling methods; the different kinds of explosives and their use in blasting; underground haulage; hoisting; surface transportation; wire rope tramways; pumping; ventilation; lighting; and sanitation.

References: Hoover, **Principles of Mining**
Young, **Elements of Mining**
Storms, **Timbering and Mining**
Brinsmade, **Mining Without Timber**
Sanders, **Mine Timbering**
Brunswig, **Explosives**
Dana and Saunders, **Rock Drilling**
Brunton and Davis, **Modern Tunneling**
Lauchli, **Tunneling**
Crane, **Ore Mining Methods.**
Gillette, **Handbook of Rock Excavation**
Ihlseng and Wilson, **Manual of Mining**
Peele, **Mining Engineer's Pocketbook**

Two hours a week during the first semester of the senior year. (Wolf)

10 METAL MINING Lectures

Credit two hours

This course includes the discussion and solution of a variety of practical mining problems which the student is likely to encounter in practice. Knowledge gained in previous mining courses is applied to problems in haulage, hoisting, surface tramming, and pumping. The selection and arrangement of surface and underground equipment is discussed. The various forms of power used in mining operations are discussed and their applications and relative advantages explained. Some of the lectures are illustrated by lantern slides of various mine structures and machinery installations; the subjects so illustrated are discussed; and the engineering principles considered in their selection and involved in their operation are explained.

References: Hoover, **Principles of Mining**
Young, **Elements of Mining**
Walker, **Electricity in Mining**
Redmayne, **Modern Practice in Mining**
Tinney, **Gold Mining Machinery**
Ketchum, **Design of Mine Structures**
Peele, **Mining Engineer's Pocketbook**
Handbook of Mining Details
Details of Practical Mining

Two hours a week during the second semester of the senior year. (Wolf)

12 MINING CORPORATIONS Lectures (Elective)

Credit one hour

This course covers the essentials of corporation law involved in the organization and operation of industrial corporations, particularly those engaged in mining. The various steps in the life of a mining corporation are discussed and analyzed, and the ordinary vicissitudes and the usual methods of facing them are illustrated by typical examples. Methods of recording a corporation's activities in the general books of accounts are explained.

References: Lough, **Corporation Finance**
Bush, **Uniform Business Law**
Wolf, **Notes on Mining Corporations**
Corporation Laws

One hour a week during the second semester of the senior year. (Wolf)

13 COAL MINING Lectures

Credit one hour

This course begins with a brief review of the geographical and geological distribution of coal, followed by a detailed discussion of the methods of mining coal. Among the subjects covered are: Prospecting coal-bearing areas; stripping and mining surface deposits; methods of opening and developing flat and steep seams; the mining of coal by room and pillar, longwall, and other systems; the methods of breaking coal at the face and the application of the mining methods to thin, thick, flat, rolling and steep beds of anthracite, bituminous, and lignite coal; methods of supporting mine workings; culm flushing; mine gases; safety lamps; ventilation; mine fans and blowers; fresh air requirements of men and animals; the influence of obnoxious gases, earth temperature and barometric pressure on ventilation; spontaneous fires; gas and dust explosions; coal mine inspection.

References: Hughes, **Textbook of Coal Mining**
Redmayne, **Modern Practice in Mining**
Mayer, **Mining Methods in Europe**
Beard, **Mine Ventilation**
Beard, **Mine Gases and Explosions**
Wilson, **Mine Ventilation**
Lamprecht, **Recovery Work After Pit Fires**
Coal Miners' Pocketbook
United States Bureau of Mines, Publications

One hour a week during the first semester of the senior year. (Wolf)

14 COAL MINING Lectures

Credit two hours

This course includes the study of coal mining machinery and equipment. The following subjects are discussed: Construction and use of punchers, shearing machines, and bar, disc and chain cutters, operated by compressed air and electricity; underground haulage systems; mine drainage systems and pumping installations; types of pit cars and mechanical devices for loading; design, installation and housing of mine fans; arrangement of surface plants and the design of head-frames, tipples, breakers, and washers; bar, revolving and shaking screens; automatic weighing devices; compressed air and electric boxcar loaders.

References: Hughes, **Textbook of Coal Mining**
Kerr, **Practical Coal Mining**
Redmayne, **Modern Practice in Mining**
Duncan and Penman, **Electrical Equipment of Collieries**
Shearer, **Electricity in Coal Mining**
Pamely, **Colliery Manager's Handbook**
Wabner, **Ventilation of Mines**
Coal Miners' Pocketbook
United States Bureau of Mines, Publications

Two hours a week during the second semester of the senior year. (Wolf)

15 MINE VALUATION Lectures

Credit two hours

This course includes a detailed discussion of the methods of mine sampling. The sampling of fissure veins, placer deposits and coal seams is carefully explained. The measurement of ore bodies and the methods of estimating tonnage are described; and the systems of classifying ore are discussed. The course includes an analytical study of the following subjects: Factors influencing payability of ore; relation between vein width and stoping width; underground wastes and losses; mining costs; influence of mineralogical composition; losses and deductions involved in metallurgical treatment; milling, transportation and smelting costs; valuation of ore bodies; valuation of surface and underground equipment; appraisement of water rights and other privileges; investigation of geological features and the probabilities and possibilities of extension of ore bodies; calculation of maintenance and depreciation of equipment; and amortization of capital. Methods of recording assays, tabulating calculations and compiling data in comprehensive form, are described. Suggestions are given for the arrangement and presentation of the essential information required in mine reports.

References: Rickard, **Sampling and Estimation of Ore in a Mine**
Burnham, **Modern Mine Valuation**
Gunther, **Examination of Prospects**
Herzig, **Mine Sampling and Valuing**
Somermeier, **Coal, Its Composition, Analysis, Utilization and Valuation**
Spurr, **Geology Applied to Mining**
Eckel, **Iron Ores**
Hoover, **Principles of Mining**
Denny, **Diamond Drilling for Gold and Other Minerals**
Wolf, **Notes on Mine Valuation**

Two hours a week during the first semester of the senior year. (Wolf)

16 ECONOMICS OF MINING Lectures

Credit one hour

This course begins with a brief review of the fundamental principles of political economy. Then follows an analytical discussion of the underlying factors which influence the operation of the various types of industrial enterprises, with special attention to mining corporations. The different classes of corporate securities are described and the factors which influence the value of mining securities are discussed. Mining costs are classified and analyzed. The application of business principles to mining is explained and emphasized.

References: Babson, **Business Barometers**
Rickard, **Economics of Mining**
Finlay, **Cost of Mining**
Skinner and Plate, **Mining Costs of the World**
Fish, **Engineering Economics**
Conway, **Investment and Speculation**
Walker, **Political Economy**
Seager, **Economics**
Meade, **Economics**
Bullock, **Selected Readings in Economics**

One hour a week during the second semester of the senior year. (Wolf)

18 MINE MANAGEMENT Lectures

Credit one hour

This course includes a discussion of the following topics: Personal qualities involved in efficient management; value of versatile technical knowledge and experience; general and department organization of working forces; application of the principles of efficiency engineering; value of business ability

and diplomacy; influence of ideals, enthusiasm, loyalty and *esprit de corps;* systems of labor compensation; classification of labor and efficiency reward; contracts and specifications; leasing systems; marketing mine and mill products; analysis of smeltery contracts; analysis and distribution of mining costs; purchase of supplies; care and maintenance of surface and underground equipment; developing and operating policies; compilation of periodical operating reports.

References: Emerson, **The Twelve Principles of Efficiency**
Taylor, **The Principles of Scientific Management**
Parkhurst, **Applied Methods of Scientific Management**
Gilbreth, **Motion Study**
Galloway, **Business Organization**
Gestenberg and Hughes, **Commercial Law**
Brinton, **Graphic Methods of Representing Facts**
Wolf, **Notes on Mine Management**

One hour a week during the second semester of the senior year. (Wolf)

19 MINE EQUIPMENT Lectures (Elective)

Credit one hour

This course involves a detailed study of the surface and underground equipment of a typical mining property. Among the subjects considered are: Hoisting; pumping; haulage; ventilation; air compression and distribution; drilling equipment; shaft houses, blacksmith shops, machine shops, assay offices, storehouses, bunkhouse, and other buildings; tramways; and loading stations.

References: Ketchum, **Design of Mine Structures**
Siemens, **Electricity in Mining**
Current Mining Periodicals
Trade Catalogues

One hour a week during the first semester of the senior year. (Wolf)

20 RESERVOIRS AND WATERWAYS Lectures (Elective)

Credit one hour

This course involves a detailed study of the arrangement and design of typical hydraulic power plants. Some of the topics considered are: Reconnaissance; water rights; stream measurements; location and survey of reservoirs; location, design, construction, operation and maintenance of dams, spillways, headgates, flumes, pressure boxes and pipe lines; design,

operation and regulation of nozzles; impulse wheels and turbines.

References: Wegman, **Design and Construction of Dams**
Schuyler, **Reservoirs**
Frizell, **Water Power**
Mead, **Water Power Engineering**
Williams and Hazen, **Hydraulic Tables**
Wilson, **Irrigation Engineering**
Newell and Murphy, **Principles of Irrigation Engineering**
Wolf, **Notes on Reservoirs, Flumes, and Pipe Lines**

One hour a week during the second semester. (Wolf)

21 MINING LAW Lectures

Credit one hour

Beginning with an historical review of the growth of our present laws relating to mining, the course aims to cover every feature of general interest to the practicing mining engineer.

References: Morrison, **Mining Rights**
Lindley, **Mines and Mineral Lands**
Costigan, **American Mining Law**
Shamel, **Mining, Mineral and Geological Law**
Ricketts, **Manual of American Mining Law**
Reynolds, **Mining Laws of the United States and Canada**
Chism, **Synopsis of the Mining Laws of Mexico**
Reyes, **Mining Laws of Mexico**
DeKalb, **Mexican Mining Law**
Harper, **Russian Mining Regulations**

One hour a week during the first semester of the senior year. (Wolf)

22a MINE VALUATION Field Work and Mapping

Credit one hour

This course supplements Course 15, and involves field examination of small mining properties by the student, followed by the writing of suitable reports under the guidance and criticism of the department. Typical assay plans will be made by the student in the draughting room, and he will receive practice in the calculation of ore reserves.

Three hours a week during the second semester of the senior year. (Wolf)

METALLURGY

George J. Young, Professor
William George Haldane, Associate Professor

25 GENERAL METALLURGY Lectures and Recitations
Credit two hours

General principles, chemical principles, thermochemistry, heat calculations and problems, physical and chemical properties of metals, alloys, slags, fuels, refractories and metallurgical products.

Prerequisites: Courses 54, 177 and 177a
References: Fulton, Principles of Metallurgy
Hofman, General Metallurgy

Two hours a week during the first semester of the junior year. (Haldane)

26a GENERAL METALLURGY Laboratory (Elective)
Credit one hour

Practice in calorimetry and pyrometry, tests of refractories, analyses of ores, fuels and metallurgical problems, roasting of ores and desilverization of base bullion.

Prerequisite: Course 25
Reference: Haldane, Metallurgical Laboratory Notes

Three hours a week during the second semester of the junior year. (Haldane)

27 ASSAYING Lectures and Recitations
Credit one hour

General principles involved in the fire assay of gold, silver, lead, tin and platinum ores and metallurgical products.

Prerequisites: Courses 54, 155 and 155a
References: Fulton, Fire assaying
Lodge, Notes on Assaying

One hour a week during the first semester of the junior year. (Haldane)

27a ASSAYING Laboratory
Credit two hours

A laboratory course of instruction in methods of fire assaying. Co-ordinated with the lecture course in assaying.

Prerequisite: Registration in Course 27
Reference: Haldane, Laboratory Notes

Six hours a week during the first semester of the junior year. (Haldane and Young)

28 METALLURGY OF IRON AND STEEL Lectures and Recitations

Credit two hours

Constitution of iron and steel, the manufacture of wrought iron, cast iron, Bessemer and open-hearth steel, the manufacture of commercial steel shapes, foundry practice.

Prerequisite: Course 25

Reference: Stoughton, **Metallurgy of Iron and Steel**

Two hours a week during the second semester of the junior year. (Haldane)

30 METALLURGY OF LEAD Lectures and Recitations

Credit two hours

Principles of lead and lead-silver smelting, methods and appliances, refining and desilverization of base bullion, economics.

Prerequisite: Course 25

Reference: Hofman, **Metallurgy of Lead**

Two hours a week during the second semester of the junior year. (Haldane)

32 METALLURGY OF ZINC Lectures and Recitations

Credit two hours

Preparation, marketing, roasting and smelting of zinc ores, furnace construction and manufacture of retorts, chemical principles, electrolytic method, economics.

Prerequisite: Course 25

Reference: Ingalls, **Metallurgy of Zinc and Cadmium**

Two hours a week during the second semester of the junior year. (Young)

33 ORE DRESSING Lectures and Recitations

Credit four hours

Principles of ore dressing, crushing, sizing, classification, concentrating, mechanical appliance and methods. Flotation electrostatic and magnetic separation. Mills and mill systems, operation, management and costs.

Prerequisites: Courses 27 and 27a

References: Richards, **Text-Book of Ore Dressing**
Wiard, **Theory and Practice of Ore Dressing**

Four hours a week during the first semester of the senior year. (Young)

33a ORE DRESSING Laboratory

Credit one hour

Study of the construction and operation of individual machines, flow sheets in the Experimental Plant, quantitative tests upon ores by concentration, flotation, electrostatic and magnetic

appliances. The study of ores and ore dressing products by the use of the microscope and lense.

Prerequisite: Registration in Course 33
References: Richards, **Textbook of Ore Dressing**
Wiard, **Theory and Practice of Ore Dressing**

Three hours a week during the first semester of the senior year. (Young and Haldane)

36 METALLURGY OF GOLD AND SILVER Lectures and Recitations

Credit three hours

Ores and methods of treatment, principles, appliances and plants. Refining and marketing, plant operation, management and economics.

Prerequisites: Courses 33 and 33a
References: Collins, **Metallurgy of Silver**
Thompson, **Stamp Milling and Cyaniding**
Rose, **Metallurgy of Gold**
Von Bernewitz, **Cyanide Practice**

Three hours a week during the second semester of the senior year. (Young)

36a METALLURGY OF GOLD, SILVER AND COPPER Laboratory

Credit one hour

Laboratory studies in amalgamation, cyaniding and other methods of treating gold and silver ores. Roasting and leaching copper ores.

Prerequisite: Registration in Course 36
Reference: **Laboratory Notes**

Three hours a week during the second semester of the senior year. (Young and Haldane)

38 METALLURGY OF COPPER Lectures and Recitations

Credit two hours

Classification of ores and methods of treatment, discussion of principles, study of examples of treatment plants, plant operation and management, refining and marketing of copper, economics.

Prerequisites: Courses 33 and 33a
Text: Hofman, **Metallurgy of Copper**
References: Peters, **Principles of Copper Smelting, Practice of Copper Smelting**

Two hours a week during the second semester of the senior year. (Young)

40 ELECTROMETALLURGY Lectures and Recitations

Credit two hours

Electric smelting of iron, steel and other metals and products. Electrolytic refining of gold, silver, lead and copper.

Prerequisites: Courses 101, 101a, 102 and 102a

Reference: Kershaw, **Electrometallurgy**

Two hours a week during the second semester of the senior year. (Haldane)

40a ELECTROMETALLURGY Laboratory

Credit one hour

Practice, on a laboratory scale, in the production of the more common ferroalloys.

Prerequisite: Registration in Course 40.

Three hours a week during the second semester of the senior year. (Haldane)

41 METALLOGRAPHY Lectures and Recitations (Elective)

Credit one hour

Discussion of thermal analysis, the constitution of iron, steel and other alloys.

Prerequisites: Courses 25 and 28

References: Goerens, **Introduction to Metallography**
Ruer, **Elements of Metallography**

One hour a week during the first semester of the senior year. (Haldane)

41a METALLOGRAPHY Laboratory (Elective)

Credit one hour

Practice in the thermal analysis, preparation of specimens for microscopic study, microscopic study of prepared specimens, microphotographic work.

Prerequisite: Registration in Course 41

Three hours a week during the first semester of the senior year. (Haldane)

45 METALLURGY OF THE MISCELLANEOUS METALS Lectures (Elective)

Credit two hours

The treatment of bismuth, arsenic, mercury, tungsten and other ores.

Prerequisite: Course 25

Two hours during the first semester of the senior year. (Young)

47 RESEARCH IN ORE-TREATMENT (Elective)

This course is intended primarily for postgraduate students or others who may have specific problems in ore treatment.

Hours and credits to be arranged. (Young)

49 RESEARCH IN FUELS, METALS AND ALLOYS (Elective)

This course is intended primarily for postgraduate students or others who may have specific problems in the study of metals, fuels and refractories.

Hours and credits to be arranged (Haldane)

50 DESIGN OF METALLURGICAL PLANTS Laboratory (Elective)

Credit one hour

This course covers the preparation of working drawings and specifications for the construction of ore dressing, cyanide and smelting plants.

Prerequisite: Postgraduate standing or completion of first semester work in the senior year.

Three hours a week during the second semester of the senior year. (Young)

GEOLOGY AND MINERALOGY

Horace Bushnell Patton, Professor
Victor Ziegler, Associate Professor

In conformity with the general policy of the School, the courses offered in this department are planned with a view to giving the student practical familiarity with those branches likely to be of most service to a mining engineer.

51 GENERAL GEOLOGY Lectures
Credit three hours

The aim of this course is to present the fundamentals of geology by means of lectures supplemented by the study of the text-book, and by assigned readings. The course is a study of physical geology. It comprises a brief survey of rocks and minerals, physical geography, and the agencies producing changes in the surface of the earth.

Prerequisites: Entrance requirements
Text: Pirsson and Schuchert, **A Textbook of Geology**

Lectures three hours a week during the first semester of the freshman year. (Ziegler)

52 GENERAL GEOLOGY Lectures
Credit two hours

This course is a continuation of Course 51. It is a study of primary and secondary rock structures, with emphasis on the secondary features due to earth movements, such as faults and folds and the value of their proper interpretation to the mining engineer.

Prerequisite: Course 51
Text: Pirsson and Schuchert, **A Textbook of Geology, Part I**
References: Leith, **Structural Geology**
Lahee, **Field Geology**
Grabau, **Principles of Stratigraphy**

Two hours a week during the second semester of the freshman year. (Ziegler)

53 CRYSTALLOGRAPHY Lectures and Laboratory
Credit four hours

This course is treated as an essential part of the general work in mineralogy. Only such portions of the subject are

especially emphasized as are of practical value in the determination and proper understanding of minerals. A very thorough drill, however, is given in the more practical portions of the subject. This course is presented through lectures, text book and practical laboratory work; also by individual quizzes. In the laboratory work each student is required to become thoroughly familiar with crystal forms and combinations such as are found on the usual wooden crystal models, and to determine with the aid of a pocket lens and contact goniometer the crystal forms of three hundred crystals.

Prerequisites: Entrance requirement

Text: Patton, **Lecture Notes on Crystallography**

Lectures two hours, laboratory six hours a week during the first twelve weeks of the sophomore year.

(Patton, Ziegler)

54 MINERALOGY Lectures and Laboratory

Credit four hours

This course begins about the end of the first week in December with a drill for four weeks in the methods of blowpipe analysis, with a view to preparing the student for the practical determination of minerals. This is followed by determinative mineralogy, which continues until the close of the second semester of the sophomore year. About two hundred fifty of the most important mineral species are presented by lecture, in which special emphasis is laid on the recognition of minerals by means of their physical properties and crystal forms. The object constantly kept in mind is not the training that will enable one to determine any mineral whatever, but rather to recognize at sight such minerals as are likely to be met in connection with mining operations. In this work each student is expected to handle, to determine and to be questioned and examined on approximately two thousand five hundred individual specimens.

Prerequisite: Course 53

Text: Butler, **Pocket Handbook of Blowpipe Analysis**

References: Brush-Penfield, **Manual of Determinative Mineralogy**
Dana, **Manual of Mineralogy**
Lewis, **Determinative Mineralogy**
Dana, **System of Mineralogy**

Lectures two hours, laboratory six hours a week beginning about the first week in December and continuing to the close of the second semester of the sophomore year.

(Patton, Ziegler)

55 HISTORICAL GEOLOGY Lectures and Laboratory
Credit four hours

The main object of this course is to give the student a general, but brief, survey of the earth's history. He will be taught how to interpret and associate the major geologic phenomena of the world. Special consideration will be given to the geology of this continent. To this end emphasis will be laid upon the stratigraphical and structural phases of the continents as determined by the epeirogenic and orogenic movements through which they have passed. The economic products, the life system, and the character of the rocks of each time division will receive their proper consideration. Part of the laboratory consists of field trips.

Prerequisites: Courses 51 and 52

References: Pirsson and Schuchert, **A Textbook of Geology, Part II**
Cleland, **Geology**
Chamberlin and Salisbury, **Geology, Problems of American Geology**

Lectures three hours, laboratory three hours a week during the first semester of the junior year. (Ziegler)

56 LITHOLOGY Lectures and Laboratory
Credit three hours

This is a lecture course supplemented by laboratory work. The object is to present all the more commonly occurring rocks in such a way as to render their identification at sight reasonably accurate. The methods pursued are purely those applicable to hand specimens without the aid of microscopic sections. The collection of the school is especially rich in those rocks that are usually met in mining operations in Colorado and adjacent States. Special emphasis, therefore, is laid upon such rocks and upon their various alteration forms.

Prerequisite: Course 54

Text: Kemp, **Handbook of Rocks**

References: Iddings, **Igneous Rocks**
Weinschenck-Johannsen, **Fundamental Principles of Petrology**
Daly, **Igneous Rocks and Their Origin**

Lecture two hours, laboratory three hours a week during the second semester of the junior year.

(Patton, Ziegler)

61 MICROSCOPIC PETROGRAPHY Lectures and Laboratory (Elective)
Credit three hours

In this course the study of rocks and rock-forming minerals is carried on with the help of the petrographic microscope. It

covers (a) the study of the optical properties of minerals with a view to their identification, and (b) systematic petrography, or the identification of rock type by means of their structures and mineral components.

Prerequisite: Course 56

References: Johannsen, **Manual of Petrographic Methods**

Lectures and laboratory six hours a week during the first semester of the senior year. (Patton)

62 THE INTERPRETATION OF MAPS Lectures and laboratory (Elective)

Credit two hours

This course is essentially a practical application of structural geology (Course 67). It is intended to assist the engineer in working out the geological structure of any district from its topographic and geologic map.

Prerequisites: Courses 51, 52 and 55

One lecture and one laboratory period during the second semester of the junior or senior year. (Ziegler)

63 ECONOMIC GEOLOGY Lectures

Credit two hours

This course treats of the nature, origin, and occurrence of ore deposits. Special attention is given to the ores which carry the more valuable metals, and to the more important mining camps of the West. The work is carried on principally by lectures with the aid of a text book.

Text: Ries, **Economic Geology**

References: Lindgren, **Mineral Deposits**
Beyschlag, Vogt and Krutch, **Deposits of Useful Minerals and Rocks**

Two hours a week during the first semester of the senior year. (Patton)

64 ECONOMIC GEOLOGY Lectures

Credit three hours

This is a continuation of Course X, but takes up, in addition to a further discussion of metallic ore deposits, the more important non-metallic products and their sources.

Prerequisite: Course 63

Text: Ries, **Economic Geology**

References: Lindgren, **Mineral Deposits**
Beyschlag, Vogt and Krutch, **Deposits of Useful Minerals and Rocks**

Three hours a week during the second semester of the senior year. (Patton)

65 THE GEOLOGY OF OIL AND GAS Lectures (Elective)
Credit three hours

This course deals with the possible origin, types of occurrence, their geologic setting, and the various reasons for the accumulation of these hydrocarbons, as well as their known geographical distribution over the world. The object of the course is to familiarize the student with all the possible ways in which the substances occur geologically, and an effort will be put forth to prepare him in the recognition of the interpretation of the accompanying field phenomena of these economic deposits.

Prerequisites: Courses 51, 52, 53, 54, and 55, or may be be taken in conjunction with 55

References: Hager, **Practical Oil Geology**
Johnson and Huntley, **Oil and Gas Production**
Engler and Hoefer, **Das Erdöl**
Bacon and Hamor, **The American Petroleum Industry**

Three hours a week during the first semester.

(Ziegler)

67 STRUCTURAL GEOLOGY Lectures (Elective)
Credit two hours

This course includes a comprehensive discussion of rock structures with special emphasis on features important to the mining engineer. Field methods and the graphical study of folds and faults receive special attention.

Prerequisites: Courses 51 and 52

References: Leith, **Structural Geology**
Lahee, **Field Geology**
Grabau, **Principles of Stratigraphy**
Geikie, **Structural and Field Geology**
Hayes, **Handbook for Field Geologists**
Leith and Mead, **Metamorphic Geology**
Tolman, **Graphical Solution of Fault Problems**
Daly, **Igneous Rocks and Their Origin**

Two hours a week during the first semester.

(Ziegler)

68a FIELD GEOLOGY
Credit three hours

This course is intended to give field practice in geologic mapping and in the working out of structural details. An area is selected for which a topographic base map has already been prepared. This area is divided up among individual squads and

a complete map with structural sections is prepared through co-operation of the different squads. The work covers four weeks, and is given immediately following commencement at the close of the junior year. Camping equipment and instruments are furnished by the school. The student is expected to furnish bedding.

The expenses of the course will vary somewhat according to the location of the area worked. Ordinarily forty to forty-five dollars should cover all expenses, including transportation, cost of equipment, and board.

Prerequisites: Courses 55 and 56

(Patton, Ziegler)

CIVIL ENGINEERING

Harry Munson Showman, Assistant Professor

The aim of this department is to develop the student along such lines in civil engineering as may be required of a mining engineer. This includes a knowledge of plane surveying, analytical and applied mechanics, structural design, and hydraulics.

76 THEORY OF PLANE SURVEYING Lectures
Credit one hour

The purpose of this course is to give preliminary instruction in the principles involved in surveying, and by numerous problems to enable the student to acquire speed and accuracy in calculations. Units and general methods of measurement are taken up first and are followed by chaining and transit problems; leveling, stadia surveying, plane-table mapping, and topographic surveying are studied in order. City, land, and railroad surveying are covered briefly. Methods of computation are thoroughly studied. These include closing and adjustment of traverses; omitted measurements; areas; parting off land; earthwork; and the reduction of solar observations for a true meridian.

Prerequisites: Courses 205 and 207
Text: Breed and Hosmer, **Plane Surveying, Vol. 1**
References: Johnson and Smith, **Theory and Practice of Plane Surveying**
Breed and Hosmer, **Higher Surveying, Vol. 2**
Wilson, **Topographic Surveying**
Tracy, **Plane Surveying**

One hour a week during the second semester of the freshman year. (Showman)

76a PRACTICE OF PLANE SURVEYING Lectures and Field Work
Credit five hours

The field work in plane surveying is conducted in the vicinity of Golden and comprises chaining, differential and profile leveling, triangulation, traversing, and numerous exercises with the transit. A topographical map of an extended territory is made by each squad, using the transit and stadia. In addition, several days are spent with the plane table in rapid mapping. At all times the combination of accuracy with economy of time

is emphasized. Lectures are held as often as necessary to give detailed instruction in the adjustment and manipulation of instruments.

Prerequisite: Course 76
References: Searles, **Field Engineering**
Pence and Ketchum, **Surveying Manual**
Johnson and Smith, **Theory and Practice of Plane Surveying**
Breed and Hosmer, **Higher Surveying, Vol. 2**
Wilson, **Topographic Surveying**

Six weeks following the close of the freshman year.
(Showman)

77 ANALYTICAL MECHANICS Lectures and Recitations
Credit five hours

This course consists of the study of the fundamental and derived laws of matter, force and motion, with their application to engineering problems. The chief topics treated are composition and resolution of forces; solution of framed structures; attraction and gravitation; center of gravity; moment of inertia; kinetics of a particle; projectiles; work; power; energy; friction; kinetics of rigid bodies; and impact. The course is taught by text assignments, with lectures and recitations. Special emphasis is placed upon problem work.

Prerequisites: Courses 213, 214, 177, and 177a
Text: Fuller and Johnston, **Applied Mechanics, Vol. I**
References: Minchin, **Treatise on Statics**
Routh, **Dynamics**
Ziwet, **Theoretical Mechanics**
Church, **Mechanics of Engineering**
Maurer, **Technical Mechanics**
Church, **Notes and Examples in Mechanics**

Five hours a week during the first semester of the junior year. (Showman)

78 APPLIED MECHANICS Lectures and Recitations
Credit three hours

This is a continuation of Course 77, and consists of the study of elastic bodies; stresses and strains; tension; shear compression; torsion; flexure; combined stresses; elastic curves; safe loads; oblique forces; long columns; hooks; simple and continuous beams.

Prerequisite: Course 77
Texts: Boyd, **Strength of Materials**
Cambria Steel

References: Merriman, **Mechanics of Materials**
Burr, **Elasticity and Resistance of the Materials of Engineering**
Lanza, **Applied Mechanics**

Three hours a week during the second semester of the junior year. (Showman)

80 TESTING LABORATORY
Credit one hour

In this course tests are made to determine the strength and stiffness of building materials, such as cast-iron, wrought-iron, steel, plain and reinforced concrete, and wood in tension, compression, shearing, and flexure. Stone and brick are examined for strength, absorption, disintegration and other qualities which decide their economic values. Experiments to determine the strength of threaded bolts, riveted joints, welds, and nailed joints are included in the course. Tests of cement are made as specified by the American Society for Testing Materials.

Prerequisite: This course must be taken in conjunction with, or subsequent to, Course 78.

References: Merriman, **Mechanics of Materials**
Burr, **Elasticity and Resistance of the Materials of Engineering**
Lanza, **Applied Mechanics**
Martens, **Handbook of Testing Materials**
Hatt and Scofield, **Laboratory Manual of Testing Materials**

Three hours a week during the second semester of the junior year. (Showman)

83 HYDRAULICS Lectures
Credit two hours

This course opens with a brief treatment of hydrostatics, takes up the theory and practical application of the properties of fluids in motion, and includes steady flow of liquids through pipes and orifices and over weirs; fluid friction and losses of head; time of emptying vessels; uniform flow of water in open channels; impulse and resistance of fluids; pumps and rams; the impulse water motor; overshot, breast, and undershot waterwheels; back water; theorem for flow in revolving pipe; turbine and reaction wheels, and the theory of turbine testing.

Prerequisite: Course 77
Text: Daugherty, **Hydraulics**
References: Merriman, **Treatise on Hydraulics**
Hughes and Safford, **Hydraulics**
Russell, **Textbook on Hydraulics**
Church, **Hydraulics**

Two hours a week during the first semester of the senior year. (Showman)

83a HYDRAULICS Laboratory

Credit one hour

Measurements are made of flow over weirs, through orifices, and through flumes and ditches. The determination of the approximate law of flow in pipes also forms part of the course. Water-wheels and centrifugal pumps are tested and the efficiency of the hydraulic ram under various conditions is determined.

Prerequisite: This course can be taken only in conjunction with Course 83

Text: Church, **Hydraulics**

References: Merriman, **Treatise on Hydraulics**
Hughes and Safford, **Hydraulics**
Russell, **Textbook on Hydraulics**

Three hours a week during the first semester of the senior year. (Showman)

85 ENGINEERING CONSTRUCTION Lectures and Drawing (Elective)

Credit three hours

In this course instruction is given in graphical analysis of the stresses of framed structures of the simpler forms. Comparison is made with the algebraic solutions of the same problems as far as practicable. The design of roof and bridge trusses in steel is then taken up from the theoretical and practical points of view. Steel mill buildings are thoroughly discussed, an analysis of all stresses involved is made, and a complete design is required from each student. In connection therewith the forms, coverings, lighting, ventilation, erection, and similar topics are carefully considered. The design and construction of steel head-frames and ore bins are taken up in detail.

Prerequisite: Course 77.

Texts: Ketchum, **Steel Mill Buildings**
Cambria Steel
Lecture Notes

References: Ketchum, **Structural Engineer's Handbook**
Morris, **Designing and Detailing Simple Steel Structures.**

Lectures and drawing eight hours a week during the first semester of the senior year. (Showman)

86 STRUCTURAL DETAILS Lectures and Drawing (Elective)

Credit two hours

This course is a study of the methods of framing heavy timber. The student is first made familiar with the terms of framing, such as housing, notching, mortise and tenon, dovetailing, lag-screws, dowels and lugs, and from accepted unit stresses, he is led to design joints, splices, deepened beams, trussed beams,

and head-frames from wood. A complete design of a combination wood and steel truss is required from each student. A brief study is made of the ordinary timbers used in construction, and the best modern methods of protecting them from the action of the elements and wood-destroying insects.

Prerequisite: Course 77
Texts: Jacoby, **Structural Details**
Cambria Steel
Lecture Notes
Reference: Kidder, **Architect's and Builder's Pocketbook**

Lectures and drawing six hours a week during the second semester of the senior year. (Showman)

ELECTRICAL ENGINEERING

William Jonathan Hazard, Professor
Ralph Roy Knowles, Instructor

101 DIRECT CURRENT MACHINERY Lectures
Credit three hours

This course covers the operating principles of direct current machines, methods of connection, auxiliary apparatus used, field of usefulness of each type, and the calculation of circuits.

Prerequisites: Courses 177, 177a, 178 and 178a
Text: Gray, **Principles and Practice of Electrical Engineering**
References: Morse, **Storage Batteries**
Crocker and Arendt, **Electric Motors**
Lyndon, **Storage Battery Engineering**
Jansky, **Electrical Meters**
Langsdorf, **Principles of Direct Current Machines**
Franklin and Esty, **Elements of Electrical Engineering, Direct Currents**

Three hours a week during the first semester of the junior year. (Hazard)

101a DIRECT CURRENT MACHINERY Laboratory
Credit one hour

In this work the common types of voltmeters, ammeters, and wattmeters are studied and calibrated, switchboards are drawn and used; and the common generators and motors, including the three wire and interpole machines, are studied. Several forms of controllers are wired up and used.

Prerequisite: Registration in Course 101
References: Swenson and Frankenfield, **Testing of Electromagnetic Machinery, Vol. 1**
Karapetoff, **Experimental Electrical Engineering, Vol. 1**

Three hours a week during the first semester of the junior year. (Hazard, Knowles)

102 ALTERNATING CURRENT MACHINERY Lectures
Credit three hours

The plan of this course is similar to that of Course 101, but deals with alternating current machinery.

Prerequisite: Course 101
Text: Gray, **Principles and Practice of Electrical Engineering**
References: Miller, **American Telephone Practice**
Van Deventer, **Telephonology**
Lawrence, **Principles of Alternating Current Machinery**
Bailey, **The Induction Motor**
Franklin and Esty, **Elements of Electrical Engineering, Alternating Currents**

Three hours a week during the second semester of the junior year. (Hazard)

102a ALTERNATING CURRENT MACHINERY Laboratory

Credit two hours

A study is first made of the alternating current instruments which are subsequently used in the experimental work. This is followed by a variety of experiments on inductive circuits. Transformers are connected and used in a variety of ways. The starting and running characteristics of induction motors are studied under normal conditions and under some abnormal conditions that are frequent causes of trouble. Synchronizing is done in several ways.

Prerequisite: Registration in Course 102.
References: Swenson and Frankenfield, **Testing of Electromagnetic Machinery, Vol. 2**
Karapetoff, **Experimental Electrical Engineering, Vol. 2**

Six hours a week during the second semester of the junior year. (Hazard, Knowles)

105 ELECTRICITY APPLIED TO MINING Lectures (Elective)

Credit three hours

The course includes a discussion of the characteristics of electrical machines and auxiliaries which are adapted to the needs of the various operations of mining and milling. Calculations are made for simple installations, using an electrical handbook for construction data.

Prerequisites: Courses 101, 101a, 102 and 102a.
Text: Croft, **American Electrician's Handbook**
References: Davies, **Foundations and Machinery Fixing**
Standard Handbook for Electrical Engineers
Koester, **Hydroelectric Developments and Engineering**
Underhill, **Solenoids, Electromagnets and Electromagnetic Windings**

Coombs, **Pole and Tower Lines**
Rosenthal, **Transmission Calculations**
Lundquist, **Transmission Line Construction**
Shearer, **Electricity in Coal Mining**
Duncan and Penman, **Electric Equipment of Collieries**

Three hours a week during the first semester of the senior year. (Hazard)

105a APPLIED ELECTRICITY Laboratory (Elective)

Credit one hour

This is the laboratory course accompanying 105. It includes a study of the standard hand operated compensators with "no voltage" and "overload" releases, resistance starters, automatic contactor starters, motor driven fans and various tests of generators and motors.

Prerequisites: Same as for 105

Three hours a week during the first semester of the senior year. (Hazard, Knowles)

This department offers two general classes of electives. The first class includes such courses as 105 and 105a, which are intended for students who have completed the required junior work and want a more extended course.

Credit hours obtained for these electives are applied on the total hours required for graduation. In this class are certain design courses, which can be adapted to the need of the student and the time available.

The second class of electives is offered for the benefit of students who, because of irregularities, find it difficult to arrange a schedule of enough hours to make a satisfactory semester's work. Such courses may be taken only with the approval of the electrical department and the registration committee. There are no fixed prerequisites. Credit for these courses will not necessarily apply on the total hours required for graduation and will not, in any case, be substituted for any required course.

The work in these courses is of the nature of that offered by manual training and trade schools. Only a few students can be accommodated, owing to the present limits of time and apparatus.

Other elective courses in electricity are offered by the department of physics.

MECHANICAL ENGINEERING

Ransom Smith Hawley, Professor
Frederick William Lucht, Jr., Instructor
Ralph Roy Knowles, Instructor

127a ENGINEERING DRAWING Drawing

Credit three hours

The object of this course is to give the student the fundamental principles of drafting according to modern drafting room and shop methods. Considerable time is devoted to freehand lettering, dimensioning, freehand sketching, and detail drawings of simple models.

Prerequisites: Entrance requirements.
Text: French, **Engineering Drawing**
References: Reinhardt, **Lettering**
French and Meikeljohn, **Lettering**
Jacoby, **Lettering**
Hawley, **Notes**

Nine hours a week during the first semester of the freshman year. (Lucht, Hawley)

128 DESCRIPTIVE GEOMETRY Lectures

Credit two hours

This course includes a study of elementary projection; simple problems relating to the point, line, and plane; methods of representation of simple solids; intersecting of solids; and development of surface.

Prerequisites: Entrance requirements
Texts: Smith, **Practical Descriptive Geometry**
French, **Engineering Drawing**
References: Church and Bartlett, **Descriptive Geometry**
Faunce, **Descriptive Geometry**

Two hours a week during the second semester of the freshman year. (Lucht, Hawley)

128a ADVANCED ENGINEERING DRAWING Drawing

Credit two hours

This course supplements the lecture course and includes the direct application and graphical solution of the problems that are studied in the lecture room.

Prerequisite: Course 127a
Text: Smith, **Practical Descriptive Geometry**
References: French, **Engineering Drawing**
Hawley, **Notes on Engineering Drawing**

Six hours a week during the second semester of the freshman year. (Lucht, Hawley)

129 ELEMENTARY MACHINE DESIGN Lectures

Credit two hours

This course includes a study of machine elements, the nature of materials entering into machine construction, and elementary calculations involving the strength of materials.

Prerequisites: Courses 128 and 128a
Text: Low and Bevis, **Machine Drawing and Design**
References: Spooner, **Machine Design**
Marshall, **Machine Design**
Smith and Marx, **Machine Design**
Kent, **Mechanical Engineer's Pocketbook**

Two hours a week during the first semester of the sophomore year. (Hawley, Knowles)

129a ELEMENTARY MACHINE DESIGN Drawing

Credit one hour

The object of this course is to give the student the principles of orthographic projections when applied to machine drawings executed according to modern drafting and shop practice. Considerable time is devoted to correct methods of lettering and dimensions of drawings and free-hand sketching. Working drawings, made from models, are submitted of the following: anchor-bolts, shaft-couplings, hangers, pipe-joints, valves, and simple engine parts.

Prerequisites: Courses 128 and 128a
Text: Low and Bevis, **Machine Drawing and Design**
References: Spooner, **Machine Design**
Marshall, **Machine Design**
Smith and Marx, **Machine Design**
Kent, **Mechanical Engineer's Pocketbook**

Three hours a week during the first semester of the sophomore year. (Hawley, Knowles)

130 KINEMATICS OF MACHINERY Lectures

Credit two hours

This course begins with the theoretical analysis of mechanism and extends to the practical application of these principles to such problems as arise in practice. Special attention is given

to the analysis of links, belting, cams, gears, and other contact mechanisms.

Prerequisites: Courses 129 and 129a
Text: Keown, **Mechanism**
Reference: Schwamb and Merrill, **Elements of Mechanism**

Two hours a week during the second semester of the sophomore year. (Hawley, Knowles)

130a KINEMATICS OF MACHINERY Drawing

Credit one hour

This course supplements and is directly dependent upon the lecture work. Designs and complete drawings are made of machine parts, gears, cams, and various systems for the transmission of power.

Prerequisites: Courses 129 and 129a
Text: Keown, **Mechanism**
Reference: Schwamb and Merrill, **Elements of Mechanism**

Three hours a week during the second semester of the sophomore year. (Hawley, Knowles)

132 HEAT ENGINES Lectures

Credit two hours

The lecture and text-book work cover the laws of thermodynamics, the theory, principles of design, construction, and operation of boilers, steam and gas engines, and auxiliaries. Practical problems are assigned the student and stress is laid upon all matters pertaining to the economical side of the subject.

Prerequisite: Course 177
Text: Allen and Bursley, **Heat Engines**
References: Goodenough, **Thermodynamics**
Streeter, **Internal Combustion Engines**
Moyer, **Steam Turbine**

Two hours a week during the second semester of the junior year. (Hawley)

132a HEAT ENGINE DESIGN Drawing

Credit two hours

The drafting room work is devoted to the design of apparatus found in steam power plants. A typical problem is the design of a tubular boiler and its setting with complete working drawings.

Prerequisite: Registration in Course 132
Text: Allen and Bursley, **Heat Engines**
References: Goodenough, **Thermodynamics**
Streeter, **Internal Combustion Engines**
Moyer, **Steam Turbine**
Trade Catalogues
Blue prints

Six hours a week during the second semester of the junior year. (Hawley, Lucht, Knowles)

133 AIR COMPRESSORS AND PUMPS Lectures

Credit three hours

This course includes a study of the theory and practice of air compression. Considerable time is given to the study of such principles of thermodynamics as are necessary to a successful understanding of the subject. After this the work comprises a study of single and multiple stage compression; absorption of heat during compression; transmission of power by compressed air; effects of moisture; reheating; valve construction; and types of compressors. The latter part of the course is devoted to a study of pumps and pumping machinery, with special reference to mine service. Steam, electricity, and compressed air as applied to pumping are carefully studied and a complete problem involving calculations of various types of pump for given conditions is carried out.

Prerequisites: Courses 132 and 132a.
Texts: Peele, **Compressed Air**
Greene, **Pumping Machinery**
References: Thorkelson, **Compressed Air**
Richards, **Theory of Compressed Air**
Simons, **Compressed Air**
Ivens, **Pumping by Compressed Air**
Nickel, **Direct Acting Pumps**
Trade Catalogues

Three hours a week during the first semester of the senior year. (Hawley)

134 MINE POWER PLANTS Lectures

Credit two hours

This course includes a detailed study of the units and auxiliaries necessary to mine power plants and their various connecting links. Problems affecting the type and location of plants are taken up. The best selection of type and number of units, arrangement, piping, connections, distribution and housing for equipment are carefully considered. Stress is laid upon items of first cost, operating cost, and depreciation.

Prerequisite: Course 133
Text: Gebhardt, **Power Plant Engineering**
References: Hutton, **Power Plants**
Meyer, **Power Plants**

Two hours a week during the second semester of the senior year. (Hawley)

134a DESIGN OF MINE POWER PLANTS Drawing

Credit two hours

The work of this course involves the calculations, design and working drawings of a complete mine power plant for a mine of a certain daily output. This includes calculations for size of power units, compressors, pumps, stack foundations, piping and all auxiliaries in connection with a completely equipped mine plant.

Prerequisite: Registration in Course 134
Text: Gebhardt, **Power Plant Engineering**
References: Hutton, **Power Plants**
Meyer, **Power Plants**
Trade Catalogues
Blueprints

Six hours a week during the second semester of the junior year. (Hawley)

135 MECHANICAL ENGINEERING Laboratory

Credit one hour

It is the purpose of this course to familiarize the student with the apparatus used in testing and engineering investigation. The practice work includes indicator practice; study of reducing motions; dynamometers; determination of the quality of steam; calibration of gages; valve setting; efficiency tests of boilers; flue gas analysis; test of air compressors; tests of steam turbines.

Prerequisite: Must accompany or be preceded by Course 133
Text: Moyer, **Power Plant Testing**
Reference: Smallwood, **Mechanical Laboratory Methods**

Three hours a week during the first semester of the senior year. (Knowles, Lucht)

136 INTERNAL COMBUSTION ENGINES Lectures (Elective)

Credit two hours

This course is intended to give the mining engineer a practical working knowledge of the gas engine. The theory and thermodynamics of the gas engine are carefully considered, together with the conditions affecting efficiency and operation. The best types of modern engines, together with auxiliary appa-

ratus, are taken up and discussed with regard to special features and advantages. Each student is assigned a seminar paper upon some special subject of investigation. At the conclusion of the course these papers are presented before the class. The last two weeks of the course are devoted to practice in operating and running the engines found in the laboratories.

Prerequisite: Course 132

Texts: Streeter, **Internal Combustion Engines**
Poole, **The Gas Engine**

Two hours a week during the second semester of the senior year. (Hawley)

137 MINE PLANT DESIGN Lectures and Drawing (Elective)

Credit three hours

This course involves the detailed calculations of a complete mine plant including the surface power plant, the hoist, head frame, compressors, pumps and air distributing lines. The student is assigned a problem for a certain character, location and capacity of mine. The drawings include sufficient detailed and assembled views of the surface of underground plant for installation of the equipment.

Prerequisites: Courses 134 and 134a

Hours to be arranged. (Hawley)

139 MINE PLANT TESTING (Elective)

This course is arranged with the idea of giving the student an opportunity to secure data by engineering methods from actually operating plants. Tests may be conducted upon one department of a plant or upon the plant as a whole. The proximity of the school to plants of mining and metallurgical operation affords special opportunity for carrying on this work.

Prerequisite: Course 135

Hours to be arranged.

(Hawley, Lucht, Knowles)

CHEMISTRY

Charles Darwin Test, Assistant Professor
John Christian Bailar, Assistant Professor

The courses in chemistry are arranged especially for the needs of mining and metallurgical engineers. The demands made upon chemistry by these branches of engineering require a broad knowledge of inorganic chemistry, of the theories which underlie the science, and a close acquaintance with the properties of the elements, their reactions, detection and separation.

151 GENERAL CHEMISTRY Lectures and Recitations

Credit five hours

This course begins with a brief historical sketch of the development of the science of chemistry up to the atomic era. Thereafter history is introduced only as occasion demands. Although the course rests on a structure of inorganic chemistry, the development and application of modern theories and of organic chemistry are taught as the work advances through the non-metallic elements during the first semester. Simultaneously a closer inspection of these elements is offered in the laboratory.

Prerequisites: Entrance requirements
Text: Smith, **General Chemistry for Colleges**
References: Roscoe and Schorlemmer, **Treatise on Chemistry**
Richter, **General Chemistry**
Holleman, **Textbook of Inorganic Chemistry**
Kahlenberg, **General Chemistry**
Dammer, **Handbuch der Anorganischen Chemie**
Gurelin-Kraut, **Handbuch der Anorganischen Chemie**

Lectures four hours, recitation one hour a week during the first semester of the freshman year. (Test)

152 GENERAL CHEMISTRY Lectures and Recitations

Credit four hours

The second semester proceeds with the metals, which follow in the order of their periodicity, in accordance with the periodic law. Elementary metallurgy and industrial chemistry

are introduced as the commercially important metals are considered.

Prerequisites: Entrance requirements
Text: Smith, **General Chemistry for Colleges**
References: Roscoe and Schorlemmer, **Treatise on Chemistry**
Richter, **General Chemistry**
Holleman, **Textbook of Inorganic Chemistry**
Kahlenberg, **General Chemistry**
Dammer, **Handbuch der Anorganischen Chemie**

Lectures three hours, recitation one hour a week during the second semester of the freshman year. (Test)

153 QUALITATIVE ANALYSIS Lectures

Credit one hour

This course treats of the theory of qualitative analysis and of common reactions and tests for metals and acid radicals. The chemistry of these reactions is carefully drilled and studied. The Law of Mass Action and the Disassociation Theory are dwelt upon in this work.

Prerequisites: Entrance requirements
Text: Noyes, **Qualitative Analysis**
References: Prescott and Johnson, **Qualitative Analysis**
Medicus, **Qualitative Analysis**
Fresenius, **Qualitative Analysis**
Menschutkin, **Analytical Chemistry**
Treadwell, **Analytical Chemistry, Vol. 1**

One hour a week during the first semester of the freshman year. (Bailar)

153a QUALITATIVE ANALYSIS Laboratory

Credit one hour

The practice of manipulation and the laboratory study of the bases and acids, their reactions, characteristics, and detection are begun.

Prerequisites: Entrance requirements
Text: Noyes, **Qualitative Analysis**
References: Noyes, **Qualitative Analysis**
Prescott and Johnson, **Qualitative Analysis**
Medicus, **Qualitative Analysis**
Fresenius, **Qualitative Analysis**
Menschutkin, **Analytical Chemistry**
Treadwell, **Analytical Chemistry, Vol. 1**

Three hours a week during the first semester of the freshman year. (Bailar, Test)

154 QUALITATIVE ANALYSIS Lectures

Credit one hour

This course proceeds with the study of the bases and acids, their detection and separation by special methods, and dwells particularly upon correct manipulation, the reactions involved and precautions necessary to obtain correct results. Details are entered into concerning the treatment of compounds, including minerals and mixtures.

Prerequisites: Courses 153 and 153a
Text: Noyes, **Qualitative Analysis**
References: Prescott and Johnson, **Qualitative Analysis**
Medicus, **Qualitative Analysis**
Fresenius, **Qualitative Analysis**
Menschutkin, **Analytical Chemistry**
Treadwell, **Analytical Chemistry, Vol. 1**

One hour a week during the second semester of the freshman year. (Bailar)

154a QUALITATIVE ANALYSIS Laboratory

Credit three hours

The practice of manipulation and the study of the bases and acids are continued. Their separation and confirmatory tests follow. Analysis of complex mixtures and minerals completes the course.

Prerequisites: Courses 153 and 153a
Text: Noyes, **Qualitative Analysis**
References: Prescott and Johnson, **Qualitative Analysis**
Medicus, **Qualitative Analysis**
Fresenius, **Qualitative Analysis**
Menschutkin, **Analytical Chemistry**
Treadwell, **Analytical Chemistry, Vol 1**

Eight hours a week during the second semester of the freshman year. (Bailar, Test)

155 QUANTITATIVE ANALYSIS Lectures (Gravimetric)

Credit one hour

The work of the first semester begins with a review of the theories of solution, electrolytic dissociation, and mass action applied to analytical chemistry. The determination and separation of the elements and important radicals are considered in detail. The aim of the course is to study the general principles and methods of separation used in quantitative analysis.

Prerequisites: Courses 151 to 154a, inclusive
Text: Treadwell-Hall, **Quantitative Analysis**

References: Fresenius, **Quantitative Analysis**
Mahin, **Quantitative Analysis**
Cairns, **Quantitative Analysis**
Low, **Technical Methods of Ore Analysis**
Sutton, **Volumetric Analysis**
Menschutkin, **Analytical Chemistry**

One hour a week during the first semester of the sophomore year. (Test)

155a QUANTITATIVE ANALYSIS Laboratory (Gravimetric)

Credit three hours

The work begins with the analysis of simple salts. By this means the practice of manipulation and the observance of necessary precautions are learned. Gradually the analyses of substances of more complex nature are introduced.

Prerequisites: Courses 151 to 154a, inclusive
Text: Treadwell-Hall, **Quantitative Analysis**
References: Fresenius, **Quantitative Analysis**
Mahin, **Quantitative Analysis**
Cairns, **Quantitative Analysis**
Low, **Technical Methods of Ore Analysis**
Sutton, **Volumetric Analysis**
Menschutkin, **Analytical Chemistry**

Nine hours a week during the first semester of the sophomore year. (Test, Bailar)

156 QUANTITATIVE ANALYSIS Lectures (Volumetric)

Credit one hour

This course consists of a study of volumetric methods of analysis. First, the theory of indicators and methods of acidimetry and alkalimetry are taken up. Later, the methods of the determination of the more important substances are studied. Special attention is given to the principles of the methods used in smelter practice. Methods of electro-analysis are given.

Prerequisites: Courses 155 and 155a
Text: Bailar, **Laboratory Notes**
References: Fresenius, **Quantitative Analysis**
Mahin, **Quantitative Analysis**
Cairns, **Quantitative Analysis**
Low, **Technical Methods of Ore Analysis**
Sutton, **Volumetric Analysis**
Menschutkin, **Analytical Chemistry**

One hour a week during the second semester of the sophomore year. (Test)

156a QUANTITATIVE ANALYSIS Laboratory (Volumetric)
Credit two hours

This course covers the use of standard solutions and a study of the reactions involved. In due time the methods commonly used in metallurgical industries are introduced. A knowledge of the preparation of standard solutions and their use is acquired by a course in acidimetry and alkalimetry. This is followed by the practice of volumetric analysis in the wet assay of ores for iron, manganese, lead, zinc, copper and other metals. Practice is given in electro-analysis of typical ores.

Prerequisites: Courses 155 and 155a
Text: Bailar, **Laboratory Notes**
References: Fresenius, **Quantitative Analysis**
Mahin, **Quantitative Analysis**
Cairns, **Quantitative Analysis**
Low, **Technical Methods of Ore Analysis**
Sutton, **Volumetric Analysis**
Menschutkin, **Analytical Chemistry**

Six hours a week during the second semester of the sophomore year. (Test, Bailar)

157 INDUSTRIAL CHEMISTRY Lectures (Elective)
Credit two hours

A broader acquaintance with industrial methods of chemistry, especially in the inorganic field, is essential to the education of the engineer. The course is intended to supply this by illustrated lectures on chemistry applied to the arts and to the apparatus used therein. Among the subjects considered are explosives and the raw materials used, which include sulphur, charcoal, potassium nitrate, nitric acid, sulphuric acid, glycerine, and ammonia.

Prerequisites: Courses 151 to 154a, inclusive
References: Thorpe, **Dictionary of Applied Chemistry**
Thorp, **Outlines of Industrial Chemistry**
Rogers and Aubert, **Industrial Chemistry**

Two hours a week during the first semester of the sophomore year. (Bailar)

158 INDUSTRIAL CHEMISTRY Lectures (Elective)
Credit two hours

The second semester continues with the following subjects: clays, refractory materials, boiler compounds, and the alkali industry.

Prerequisites: Courses 151 to 154a, inclusive
References: Thorpe, **Dictionary of Applied Chemistry**
Thorp, **Outlines of Industrial Chemistry**
Rogers and Aubert, **Industrial Chemistry**

Two hours a week during the second semester of the sophomore year. (Bailar)

160 ADVANCED QUANTITATIVE ANALYSIS Lectures
(Elective)

Credit one hour

The course undertakes a continuation of the principles involved in metallurgical laboratory practice.

Prerequisites: Courses 156 and 156a

References: Fresenius, **Quantitative Analysis**
Low, **Technical Methods of Ore Analysis**
Smith, **Electroanalysis**

One hour a week during the second semester of the junior year. (Test)

160a ADVANCED QUANTITATIVE ANALYSIS Laboratory
(Elective)

Credit two hours

This is a continuation of Course 156a

Prerequisites: Courses 156 and 156a

References: Fresenius, **Quantitative Analysis**
Low, **Technical Methods of Ore Analysis**
Smith, **Electroanalysis**

Six hours a week during the second semester of the junior year. (Test)

PHYSICS

Claude Cornelius Van Nuys, Professor

The courses in Physics are intended to give the student a broad, general knowledge of the whole subject as well as the knowledge most essential to his work as a mining or metallurgical engineer. Especial attention is given to the general laws underlying the science and the history of the discovery and development of the important results is considered carefully. In the laboratory courses the purpose is to excite in the student an interest in experimentation and to develop the ability for careful observation and the testing and sifting of results.

177 MECHANICS OF SOLIDS AND FLUIDS, SOUND AND HEAT Lectures and Recitations

Credit five hours

This course consists of lectures, illustrated by experiments and recitations with assigned problems. The subjects treated are mechanics, including the elements of kinematics, dynamics, and hydrostatics; the properties of matter; heat, including thermometry and expansion, calorimetry, change of state, conduction, radiation, kinetic theory of gases, and the elements of thermodynamics; sound, including wave motion in general, production and propagation of sound waves.

Prerequisites: Courses 205, 208, and 212
Only students who are registered in Course 213 will be allowed to take this course

Text: Duff, **Textbook of Physics**

References: Preston, **Theory of Heat**
Barton, **Textbook of Sound**

Three lectures and two recitations a week during the first semester of the sophomore year. (Van Nuys)

177a PHYSICS Laboratory

Credit two hours

This course is arranged to accompany Course 177. Its aim is to teach the student the necessity of careful work as well as to acquire skill in physical measurements so that the important physical laws can be quantitatively verified.

Prerequisite: Registration in Course 177

Four hours a week during the first semester of the sophomore year. (Van Nuys)

178 GENERAL PHYSICS Lectures and Recitations

Credit five hours

This course is a continuation of 177. The subjects treated are light, including propagation, reflection, refraction, dispersion, interference, emission, absorption, and polarization; electricity and magnetism, including electrostatics, electro-kinetics, thermo-electricity, magnetic induction, electro-magnetism, electrolysis, the electro-magnetic theory, and electric oscillations; conduction of electricity through gases, and radioactivity.

Prerequisites: Courses 177, and 213
Text: Duff, **Textbook of Physics**
References: Wood, **Physical Optics**
Starling, **Electricity and Magnetism**
Thomson, **Electricity and Magnetism**

Three lectures and two recitations a week during the second semester of the sophomore year. (Van Nuys)

178a PHYSICS Laboratory

Credit two hours

This course is a continuation of 177a

Prerequisite: Course 177a

Course 178 must be taken in conjunction with this course.

Four hours a week throughout the second semester of the sophomore year. (Van Nuys)

179 ALTERNATING CURRENTS Lectures (Elective)

Credit three hours

E. m. f. and current curves, harmonic e. m. f.'s and current, circuits containing inductance and resistance, circuits containing capacity, power in alternating circuits, graphical method of investigating harmonic e. m. f.'s and currents, parallel circuits, polyphase e. m. f.'s and currents, the two-phase system, the three-phase system, delta and star connections, the alternating current transformer, general equations, solution of equations under various conditions, transformer theory as applied to a. c. motors.

Prerequisite: Course 178

Three hours a week during the first semester of the junior or senior year. (Van Nuys)

180 ELECTRON THEORY AND RADIOACTIVITY Lectures and Laboratory (Elective)

Credit three hours

Conduction of electricity through gases, Röntgen, cathode, Lenard and canal rays, moving electric charges, methods used

in the determination of the mass and charge of the electron, radioactive substances, and their transformations.

Prerequisite: Course 178

Two lectures and one laboratory period a week during the second semester of the junior or senior year.

(Van Nuys)

181 ELECTRICAL MEASUREMENTS Lectures and Laboratory (Elective)

Credit three hours

This course deals with the theory of the absolute and relative measurements of the various electrical and magnetic quantities, and includes the actual measurement of these quantities in the laboratory.

One lecture and two laboratory periods a week during the first semester of the junior year. (Van Nuys)

MATHEMATICS

Charles Roland Burger, Professor
George Eulas Foster Sherwood, Associate Professor

The courses in this department are arranged to meet the needs of the students in the various branches of engineering, and mark the minimum of mathematical attainments that an engineer ought to possess. As our experience has shown that some of the entering students are deficient in elementary algebra and solid geometry, special classes are arranged for them, but these courses do not form part of the prescribed curriculum.

201 ADVANCED ALGEBRA Recitations

This course is given for those students who are found deficient in preparatory algebra. It begins with the fundamentals and comprises a thorough review as far as quadratics.

Texts: Wells, **Advanced Course in Algebra**
Hawkes, **Advanced Algebra**

Three hours a week during the first semester of the freshman year. (Sherwood)

203 SOLID GEOMETRY Recitations

This course, like 201, is given for those students who are poorly prepared in this branch of preparatory mathematics. This course includes a complete study of the elements of solid geometry. Emphasis is placed on the mensuration of the solids.

Text: Wentworth-Smith, **Solid Geometry**
References: Chauvenet, **Plane and Solid Geometry**
Wells and Hart, **Plane and Solid Geometry**
Phillips and Fisher, **Plane and Solid Geometry**

Three hours a week during the first semester of the freshman year. (Burger)

205 COLLEGE ALGEBRA Recitations

Credit three hours

This course begins with quadratic equations. The following topics are treated: quadratic equations in one or more variables, inequalities, mathematical induction, complex numbers, loga-

rithms, variation, permutations and combinations, partial fractions, determinants, theory of equations, and infinite series.

Prerequisites: Entrance requirements
Text: Fite, **College Algebra**
References: Hawkes, **Higher Algebra**
Reitz and Crathorne, **College Algebra**

Three hours a week during the first semester of the freshman year. (Sherwood)

206 COLLEGE ALGEBRA

Credit three hours

This course is a repetition of Course 205, and is required of all students who have not completed Course 205.

Text: Hawkes, **Higher Algebra**
References: Reitz and Crathorne, **College Algebra**
Todhunter, **Algebra**
Crystal, **Algebra, Vols. I and II**
Cajori, **Theory of Equations**
Weld, **Determinants**

Three hours a week during the second semester of the freshman year. (Burger)

207 PLANE TRIGONOMETRY Recitations and Laboratory

Credit three hours

The general formulas of plane trigonometry are established. Inverse functions, identities, and trigonometric equations are carefully considered. Special attention is given to accuracy in calculations and much practice is given on such problems as the engineer meets in field and office.

Prerequisites: Entrance requirements
Texts: Crawley, **Elements of Trigonometry**
Hodgman, **Surveyor's Tables**
References: Murray, **Elements of Plane and Spherical Trigonometry**
Bôcher and Gaylord, **Trigonometry**
Wentworth, **New Plane and Spherical Trigonometry**
Jones, **Tables**

Recitations two hours, laboratory three hours a week during the first semester of the freshman year.

(Sherwood)

208 SPHERICAL TRIGONOMETRY Recitations and Laboratory

Credit two hours

The general formulas of spherical trigonometry are developed. Much practice is given on the solution of the ordinary and astronomical triangles. Such problems as arise in survey-

ing, practical astronomy, and geodesy are dwelt upon particularly.

Prerequisite: Course 207

Texts: Crawley, **Elements of Trigonometry**
Hodgman, **Surveyor's Tables**

References: Murray, **Elements of Plane and Spherical Trigonometry**
Jones, **Tables**
Bôcher and Gaylord, **Trigonometry**
Wentworth, **New Plane and Spherical Trigonometry**

Recitations one hour, laboratory three hours a week during the second semester of the freshman year.

(Sherwood)

210 PLANE AND SPHERICAL TRIGONOMETRY Recitations and Laboratory

Credit five hours

This course is a repetition of Course 207 and includes the work covered in Course 208. It is required of all students who have not completed Course 207.

Texts: Murray, **Elements of Plane and Spherical Trigonometry**
Jones, **Tables**

References: Phillips and Strong, **Trigonometry**
Lyman and Goddard, **Plane and Spherical Trigonometry**
Hun and MacInnes, **Elements of Plane and Spherical Trigonometry**

Recitations three hours, laboratory five hours a week during the second semester of the freshman year.

(Sherwood)

212 ANALYTIC GEOMETRY Lectures and Recitations

Credit four hours

The following are among the topics treated: geometry of the point and straight line; areas of plane figures; functions and their graphical representations; transformation of co-ordinates; loci of the first, second and higher orders; properties of conics; system of conics; empirical equations and their loci.

Solid analytic geometry is developed sufficiently to meet the requirements of the courses in calculus. The point, plane, straight line, cylinders of revolution, tangents, normals, quadric surfaces, and the helix are among the topics treated.

Prerequisites: Courses 205 and 207. By special permission Course 212 may be taken with 206 or 210, but not with both.

Text: Dowling and Turneaure, **Analytic Geometry**
References: Bailey and Woods, **Analytic Geometry**
Riggs, **Analytic Geometry**
Smith and Gale, **New Analytic Geometry**
Woods and Bailey, **Course in Mathematics, Vol. I**

Four hours a week during the second semester of the freshman year. (Sherwood)

213 CALCULUS Lectures and Recitations

Credit five hours

This course introduces the student to the elements of the calculus. The fundamental principles of continuity, limiting values, and the theory of infinitestimals are established. The differentiation of the fundamental forms, the application to curves and rates, maxima and minima, simple problems in quadrature, rectification, and volumes, comprise a large part of the course. A feature of the course consists in carrying on the differential and integral calculus together. This enables the student to grasp the more difficult notions of the subject in their inherent relations, and at the same time to apply this knowledge early in the course to the solution of engineering problems.

Prerequisite: Course 212
Text: Townsend and Goodenough, **Essentials of Calculus**
References: Murray, **Differential and Integral Calculus**
Woods and Bailey, **A Course in Mathematics, Vol. I**
Murray, **Infinitesimal Calculus**
Byerly, **Differential Calculus**
Williamson, **Differential Calculus**

Five hours a week during the first semester of the sophomore year. (Burger)

214 CALCULUS Lectures and Recitations

Credit five hours

This course is a continuation of Course 213. The theory of multiple integration is developed and applied extensively to problems involving areas, lengths of arcs, volumes, centers of gravity, moments of inertia, and pressure. Solids of revolution, cylinders, space curves, ruled and quadric surfaces are all given their needed emphasis. An elementary treatment of series, introducing Taylor's theorem, and a chapter on ordinary differential equations, together with numerous applications to problems in physics, mechanics, and general engineering, conclude the course.

The aim throughout is to encourage the student to look upon his calculus as an instrument of power and usefulness rather than one merely of mental development and culture.

Prerequisite: Course 213

Text: Townsend and Goodenough, **Essentials of Calculus**

References: Murray, **Differential and Integral Calculus**
Woods and Bailey, **A Course in Mathematics, Vol. II**
Byerly, **Integral Calculus**
Osgood, **Differential and Integral Calculus**
Williamson, **Integral Calculus**

Five hours a week during the second semester of the sophomore year. (Burger)

215 ADVANCED CALCULUS Lectures and Recitations (Elective)

Credit two hours

This course is a continuation of Course 214 and presents a variety of topics including: an introductory review of fundamental rules and theory, Taylor's formula and allied topics, elliptic integrals, ordinary differential equations, simple and multiple integrals, special functions defined by integrals, and an elementary treatment of the functions of a complex variable.

Prerequisite: Course 214

References: Wilson, **Advanced Calculus**
Harnack, **Introduction to the Calculus**
Byerly, **Integral Calculus**
Durége, **Elementary Theory of Functions**

Two hours a week during the first semester of the junior or senior year. (Burger)

216 ENGINEERING MATHEMATICS Lectures and Problems (Elective)

Credit two hours

This course is largely a problem course and is intended for the student who wishes to review his calculus and analytic geometry, and who wishes to acquire facility in their application to problems in engineering. The course is based upon the four volumes of V. Karapetoff and includes selected problems in machine design, hydraulics, thermodynamics, and mechanics of materials.

Prerequisite: Course 214

References: Karapetoff, **Engineering Mathematics**
Saxelby, **Practical Mathematics**
Palmer, **Practical Mathematics**
Marsh, **Practical Mathematics**

Two hours a week during the second semester of the junior or senior year. (Burger)

217 THEORY OF EQUATIONS Lectures and Recitations (Elective)

Credit two hours

This course is a continuation of Course 205, and is intended for students who have made definite progress in mathematics during the freshman and sophomore years. The course includes: the algebraic solution of equations, symmetric functions of the roots, properties and applications of determinants, calculus of imaginaries, and some of the propositions of the theory of equations which are related to trigonometry. The course is based upon Burnside and Panton's Theory of Equations and Hobson's Trigonometry.

References: Burnside and Panton, **Theory of Equations**
Hobson, **Trigonometry**
Crystal, **Algebra**
Chauvenet, **Trigonometry**
Cajori, **History of Mathematics**

Two hours a week during the first semester of the junior or senior year. (Burger)

218 THE MATHEMATICS OF INVESTMENTS Lectures and Recitations (Elective)

Credit two hours

The course is intended to meet the needs of those students who wish to familiarize themselves with the fundamentals of mathematics as related to the theory of investments, with special reference to present-day conditions and needs. Some of the topics treated are: interest, annuities, the extinction of interest-bearing debts by periodical payments, the valuation of bonds, sinking funds and depreciation, building and loan associations, the elementary theory of probability and its application to some problems in life insurance.

Text: Skinner, **The Mathematical Theory of Investment**

Two hours a week during the second semester of the junior or senior year. (Burger)

219 DIFFERENTIAL EQUATIONS Lectures (Elective)

Credit two hours

This course is an introduction to the more elementary portions of the theory of ordinary and partial differential equations. Methods are developed for solving differential equations in terms of the elementary functions. Throughout the course, constant application of the principles studied will be made to problems in geometry and applied mathematics.

Prerequisite: Course 214
References: Murray, **Differential Equations**
Cohen, **Elementary Treatise on Differential Equations**
Johnson, **Differential Equations**

Two hours a week during the first semester of the junior or senior year. (Sherwood)

220 VECTOR ANALYSIS AND QUATERNIONS Lectures (Elective)

Credit two hours

The subjects treated in this course will include: the addition of vectors, and the multiplication of scalars and vectors; scalar and vector multiplication of two vectors; applications of the principles of the calculus to vectors; vector fields; introduction to the quaternions of Hamilton and Grassmann.

Prerequisite: Course 213
References: Coffin, **Vector Analysis**
Wilson, **Vector Analysis**
Hardy, **Elements of Quaternions**
Baker, **Quaternions**

Two hours a week during the second semester of the junior or senior year. (Sherwood)

221 ASTRONOMY Lectures, Problems, and Observations (Elective)

Credit two hours

This course covers a study of the celestial sphere, including the sun, moon, earth, and planets; their motions, forms, dimensions, and physical constitution; the constellations; attraction of the moon; tides; Kepler's laws; problems of gravitation; the measurement of time; problems necessitating familiarity with, and use of, the Nautical Almanac.

Prerequisite: Course 212
Text: Hosmer, **Textbook on Practical Astronomy**
References: Chauvenet, **Spherical and Practical Astronomy, Vol. I and Vol. II**
Mason, **Introduction to Practical Astronomy**
Young, **Textbook of General Astronomy**

Two hours a week during the first semester of the junior or senior year. (Sherwood)

222 LEAST SQUARES AND PRACTICAL ASTRONOMY Lectures, Problems, and Observations (Elective)

Credit two hours

This course embraces the development of the method of Least Squares; its application to problems in astronomy, physics, chemistry, etc.; such problems of practical astronomy as may be

solved by the surveyor, including: (1) latitude by the altitude of any heavenly body at culmination; (2) solar and stellar observations for meridian; (3) longitude by transit of the moon; (4) observations for determining the time.

Prerequisite: Course 221

References: Woodward, **Probability and Theory of Errors**
Johnson, **Theory of Errors and Method of Least Squares**
Comstock, **Elementary Treatise Upon the Method of Least Squares**

Two hours a week during the second semester of the junior or senior year. (Sherwood)

ENGLISH

Carroll George Dolman, Assistant Professor

227 ENGLISH COMPOSITION Lectures
Credit two hours

This course is designed to train the student in the essentials of English composition. Practical exercises will be given to develop orderly arrangement and clear expression of thought.

Prerequisites: Entrance requirements

References: Kittredge and Farley, **Advanced English Grammar**
Canby and Others, **English Composition in Theory and Practice**
Wooley, **Handbook of Composition**

Two hours a week during the first semester of the freshman year. (Dolman)

228 BUSINESS CORRESPONDENCE Lectures
Credit one hour

This course is a continuation of Course 227. It aims to give a practical grasp of business correspondence and to familiarize the student with the type of English composition requisite as a basis for professional report writing.

Prerequisite: Course 227

References: Kittredge and Farley, **Advanced English Grammar**
Canby and Others, **English Composition in Theory and Practice**
Wooley, **Handbook of Composition**

Two hours a week during the second semester of the freshman year. (Dolman)

229 REPORTS Lectures
Credit two hours

This course is designed as a preparation for technical writing. The fundamentals of the subject will be studied and reports upon assigned topics will be required from the students.

Prerequisite: Course 228

References: Sypherd, **Handbook of English for Engineers**
Earle, **Theory and Practice of Technical Writing**
Rickard, **A Guide to Technical Writing**

Two hours a week during the first semester of the sophomore year. (Dolman)

230 TECHNICAL WRITING Lectures

Credit one hour

This course is a continuation of Course 229. The principal object of this course is to outline the best methods of presenting technical subjects for publication and for private reports.

Prerequisite: Course 229

References: Sypherd, **Handbook of English for Engineers**
Earle, **Theory and Practice of Technical Writing**
Rickard, **A Guide to Technical Writing**

One hour a week during the second semester of the sophomore year. (Dolman)

MODERN LANGUAGES

Carroll George Dolman, Assistant Professor

231 SPANISH Recitations and Conversation
Credit two hours

This course is designed primarily for those students who expect to do professional work in Spanish-American countries. Facility in conversation and business correspondence will be the chief aim. The course will be conducted in Spanish, for the most part. Sufficient reading of simple exercises and grammar will be given to enable the student to acquire a practical use of the language.

Prerequisites: Entrance requirements
References: Rosenthal, **The Spanish Language**
Berlitz, **Método Berlitz**
Cortina, **Spanish in Twenty Lessons**
Graham and Oliver, **Spanish Commercial Practice**
Dolman, **Spanish Lessons**

Two hours a week during the first semester of the freshman year. (Dolman)

232 SPANISH Recitations and Conversation
Credit two hours

This course is a continuation of Course 231, and consists of similar exercises in conversation and composition, but more advanced in character. This course will be conducted entirely in Spanish.

Prerequisite: Course 231
References: Rosenthal, **The Spanish Language**
Berlitz, **Método Berlitz**
Cortina, **Spanish in Twenty Lessons**
Graham and Oliver, **Spanish Commercial Practice**
Dolman, **Spanish Lessons**

Two hours a week during the first semester of the freshman year. (Dolman)

Elective courses in Spanish similar to 231 and 232 are offered to juniors and seniors. Advanced courses in the same subject will be arranged as occasion arises.

233 GERMAN Recitations (Elective)

Credit two hours

This course is designed for those students desiring instruction in the essentials of technical German. Various exercises in scientific German literature of moderate difficulty will be read by the class.

Prerequisite: At least two years previous study of German to be approved by the instructor.

Reference: Wait, **German Science Reader**

Two hours a week during the first semester of the junior or senior year. (Dolman)

234 GERMAN Recitations (Elective)

Credit two hours

This course is a continuation of Course 233, and consists of selected readings in scientific German literature.

Prerequisite: Course 233

Reference: Wait, **German Science Reader**

Two hours a week during the second semester of the junior or senior year. (Dolman)

Similar courses in scientific French literature will be arranged should occasion arise.

SAFETY ENGINEERING

James Cole Roberts, Professor

251 SAFETY ENGINEERING Lectures

Credit one hour

This course is designed to impress upon the student the dangers due to the presence of poisonous and explosive gases in mines, and to acquaint him with methods of detecting and eliminating such gases. Approved methods of ventilation and illumination, designed to insure conditions whereunder mining operations may be carried on with safety to life and property, are discussed.

References: Haldane, **Investigation of Mine Air**
International Engineering Congress, Transactions
United States Bureau of Mines, Publications

One hour a week during the first semester of the junior year.

(Roberts)

252 SAFETY ENGINEERING Lectures

Credit one hour

In this course the numerous safety measures are discussed which are involved in the storage, handling, and use of explosives and their accessories. Special attention is paid to permissible explosives and to the various precautions which must be observed in connection with blasting and shot firing.

References: Cowee, **Practical Safety Methods and Devices**
International Engineering Congress, Transactions
United States Bureau of Mines, Publications

One hour a week during the second semester of the junior year.

(Roberts)

253 MINE FIRES AND EXPLOSIONS Lectures

Credit one hour

This course involves a discussion of mine fires, the causes of fires, measures for their prevention, and methods of extinguishing them. Coal dust and dust explosions are discussed and the various methods of allaying dust are presented and explained.

References: Beard, **Mine Gases and Explosions**
Lamphrecht, **Recovery Work After Pit Fires**
Garforth, **Rules for Recovering Coal Mines After Explosions and Fires**
United States Bureau of Mines, Publications
United States Geological Survey, Bulletins

One hour a week during the first semester of the senior year. (Roberts)

253a MINE RESCUE Laboratory

Credit one hour

This course involves thorough instruction and training in the use of the Draeger, Westphalia, and Fluess mine rescue breathing apparatus; the pulmotor, the lungmotor, and other mechanical respiratory devices; and in the repairing and maintenance of this equipment and accessory apparatus. Each student is required to pass a satisfactory physical examination before he is allowed to take this course. The rescue work is done in the mine under conditions which would obtain in the case of an actual mine fire or explosion. The students will receive training in building brattices and bulkheads; setting timbers; putting out fires; and carrying injured men (dummies) from mine workings filled with smoke and irrespirable gases. Special attention is devoted to mine rescue practices of the federal government; and upon the value of organization and preparedness.

References: **United States Bureau of Mines, Publications**

Three hours a week during the first semester of the senior year. (Roberts)

254 ACCIDENTS Lectures

Credit one hour

In this course the causes of accidents in mines and other industrial works are analyzed and discussed; and the numerous means of preventing accidents are presented and explained. The course involves a discussion of the following topics: sanitation in mines and mining camps; education and social welfare; industrial accident commissions, and state laws relating to accidents, and workmen's compensation.

References: Sawyer, **Accidents in Mines**
United States Bureau of Mines, Publications

One hour a week during the second semester of the senior year. (Roberts)

254a FIRST AID TO THE INJURED Laboratory

Credit one hour

This course involves a practical study of physiology and anatomy. This is followed by thorough instruction and training in the care and transportation of persons injured in and about

mines, mills, and metallurgical plants. The students are required to become proficient in the use of compresses, tourniquets, bandages, splints, stretchers, etc.

References: Lauffer, **Electrical Injuries**
United States Bureau of Mines, Publications
American Red Cross, Textbook on First Aid
Johnson, **First Aid Manual**
Manson, **Tropical Diseases**
Kober and Hanson, **Diseases of Occupation and Vocational Hygiene**

Three hours a week during the second semester of the senior year.

(Roberts)

INSPECTION TRIPS

The same importance is attached to the inspection trips as to class room and laboratory work. Grades are given on reports submitted and satisfactory results are required.

MINING TRIPS

During the junior and senior years, the students are taken, from time to time, to well known Colorado mining districts for the inspection of actual mining operations. These trips are arranged in such order as to introduce different interesting features and, at the same time, to emphasize definite portions of the class room instruction. Attention is paid to surface plants, underground equipment, mining systems, and to all the regular operations, both above and below ground. Lectures precede these trips to explain their objects, the particular properties to be visited, and the operations to be witnessed. Printed outlines are furnished and each student is required to submit a report, illustrated by his own sketches.

ELECTRICAL PLANT TRIPS

Near the end of the junior year trips are made to the generating stations and sub-stations in and about Denver, where nearly all the electrical machinery studied during the year can be seen in commercial use.

METALLURGICAL TRIPS

DENVER

The plants of the American Smelting and Refining Company; the Sutton, Steele & Steele Company; the American Zinc Ore Separating Company; and miscellaneous ore-testing and manufacturing establishments.

COLORADO SPRINGS

The plant of the Golden Cycle Mining Company.

VICTOR

The plants of the Portland Gold Mining Company and other plants.

PUEBLO

The steel plant of the Colorado Fuel and Iron Company; the lead smeltery of the American Smelting and Refining Company; and the zinc smeltery of the United States Zinc Company.

GENERAL INFORMATION

TUITION

The Statutes of Colorado provide as follows:

"The said School of Mines shall be open and free for the instruction to all **bona fide** residents of this State, without regard to sex or color, and, with the consent of the Board, students from other states and territories may receive education thereat upon such terms and at such rates of tuition as the Board may prescribe."

The tuition for non-residents is one hundred fifty dollars a year, payable in two installments, seventy-five dollars at the beginning of each semester.

COURSE FOR PROSPECTORS

This course, of four weeks duration, is given annually for the benefit of prospectors and others who may be interested in mining. All of the courses will be of the most practical nature and will comprise instruction in mineralogy, common minerals and rocks; elementary chemistry; principles of ore dressing, assaying and the more common metallurgical processes; methods of valuing, buying and selling ore; placer and lode mining; location of mining claims; first aid to the injured and safety engineering. They will be given entirely by regular members of the faculty and will consist of lectures, supplemented by laboratory demonstrations.

Prospectors and others who expect to take advantage of this work are asked to notify the school authorities as soon as possible, in order that ample preparation can be made for the work. Address all correspondence to The Registrar, Colorado School of Mines, Golden, Colorado.

The course for the year 1917 opens February 5, and ends March 3.

The dates of successive terms will be announced by circular from year to year.

A single fee of two dollars is charged for the entire course of four weeks, and is payable in cash on registration.

OUTLINES OF THE COURSES OFFERED

COMMON ROCKS AND MINERALS

Professor Patton and Professor Ziegler

A course of thirty-six hours, mostly laboratory practice, devoted to the study of common minerals and rocks. The in-

struction will include blowpipe reactions, using the simplest apparatus and appliances. A few of the rarer ores in which prospectors are just now greatly interested, such as those of tungsten, molybdenum, etc., will be considered.

GEOLOGY

Professor Patton

An eight-hour lecture course devoted to such geological features as throw light on the origin and manner of occurrence of ore deposits and on the structural features frequently met with in mining. These latter include faults and folds, strikes and dips, and the mutual relationship of rock masses.

Particular attention will be given to the kinds of rocks, geological conditions, etc., which appear to affect ore deposition. An important part of prospecting is to know what may be sought for in the different formations.

CHEMISTRY

Professor Test and Professor Bailar

A course of thirty-two hours, mostly laboratory work, with such time taken for lectures as may be necessary. The object of the course is to make the prospector more familiar with the use of such apparatus and chemicals as may aid him in supplementing his field work, and to equip him with knowledge of the characteristic properties of the common metals. Some work on the commercially important rare metals will also be given.

METALLURGY AND ASSAYING

Professor Young and Professor Haldane

The work in the department of metallurgy is given in two divisions; the first division comprises eight lectures covering the subjects outlined below. In addition there will be given four afternoons demonstration work in the assaying and metallurgical laboratories. The second division comprises twelve lectures in ore dressing and metallurgy, together with four afternoons demonstration work in the experimental laboratory. The nature of the demonstration work will be determined largely by the requirements of the class.

First Division—Professor Haldane

Principles and methods of sampling as used in mines, mills and smelteries; methods of assaying common ores; determination of the value of ores from assay or analysis; how ores are bought and sold; the value of an ore to the producer; simple tests for the prospector.

Second Division—Professor Young

Nature of ores, crushing, sizing and classification; coarse and fine concentration in water; methods of dry concentration;

amalgamation; flotation; electrostatic and magnetic separation; determining percentage extraction; the cyanide process; leaching copper and zinc ores; smelting lead and copper ores; simple treatment plan for prospectors.

The laboratories and experimental plant afford exceptional opportunities for demonstration and the student will be given every reasonable facility to study methods and mechanical appliances.

PLACER MINING

Professor Wolf

This four-hour course includes a discussion of the theory and practice involved in the recovery of precious metals from sand and gravel deposits. Among the subjects considered are: panning, rocking, sluicing, hydraulicing, dredging, dry placering, etc. Typical operations are described for the purpose of illustration.

MINING CLAIMS

Professor Wolf

This eight-hour course includes instruction in the methods of acquiring title to mineral lands in the United States. Practical methods of locating and surveying mineral lands are described and instruction is given in the preparation and filing of documents used in acquiring title to lode and placer claims; mill and tunnel sites; timber, stone and coal lands; water rights. Mining laws which are important to the prospector are discussed and explained.

LODE MINING

Professor Wolf

This eight-hour course includes a discussion of surface prospecting, methods employed and equipment required. The opening and developing of prospects to the best advantage are discussed, as also proper methods of sampling in the mine and on the dump.

MINE SAFETY ENGINEERING

Professor Roberts

The course in Mine Safety Engineering includes the following:

1 General safety in mines

2 Explosives: Composition of explosives in general use in coal and metal mines and quarries; composition of resultant gases from explosives and the dangers of going back too soon after shots are fired; the proper and improper methods of handling explosives

3 Mine gases: gases encountered in coal and metal mines, prospect holes and shafts; their composition; methods of detecting and removing same; and precautions to be taken to prevent

accumulation; methods of recovering and removing men overcome by gases

4 Mine lighting

5 Mine fires: their causes, methods of preventing and extinguishing them

6 Mine rescue methods and appliances, including demonstrations of various types of mine rescue apparatus in use, resuscitating devices, pulmotor, lung motor, etc.

7 First aid to the injured: a full and complete course in first aid will be given at night to all those who care to take it. This will include the following: The human body; wounds, with and without bleeding; bruises, sprains and dislocations; fractures, simple and compound; bandages and splints; shock, fainting, poisoning, etc.

TEXT-BOOKS AND STUDENTS' SUPPLIES

The cost of text-books and students' supplies necessarily varies, but the following are fair estimates, probably maxima:

Freshman year:	Text-books	$20.00
	Drawing supplies	20.00
Sophomore year:	Text-books	20.00
Junior year:	Text-books	25.00
Senior year:	Text-books	25.00

BOARD AND LODGING

The school has no dormitory. Board can be obtained in private families for five to six dollars a week. Students' clubs furnish board for about twenty dollars a month. Rooms can be obtained for eight dollars to twelve dollars a month.

OTHER EXPENSES

There are other expenses incidental to the mining, metallurgical, engineering, chemical, and geological trips, which vary so widely that they can not be estimated.

Students leaving in mid-term, except on account of severe or protracted sickness, are not entitled to the return of fees or tuition. **All charges of the school are payable strictly in advance at the beginning of each semester.** No student is allowed to be graduated while indebted to the school. The Trustees reserve the right to make incidental changes in fees and deposits without printed notice, as new and unforeseen emergencies may arise.

Students who desire to earn money to defray their school expenses are advised to limit their work to the summer vacation. The course of study is too exacting to allow much time during the college year for outside work.

The total expenses of the college year, including room and board but exclusive of tuition, need not exceed five hundred dollars, and may be reduced considerably by strict economy.

THE QUARTERLY

Four times a year, in January, April, July, and October, the school issues the Quarterly. The various numbers include the Catalog, the Book of Views, Commencement addresses, and articles of a mining or of a metallurgical nature.

METHOD OF GRADING

The following system of grading is used:

A—Excellent
B—Good
C—Fair
D—Conditioned
E—Failed or Subject Dropped

A, B, and C are passing grades.

D (Conditioned) means that the student is not passed. The deficiency may be removed by passing a re-examination or by otherwise completing the work. Unless a condition is removed before the beginning of the next school year the D becomes an E.

E (Failed or Subject Dropped) means that the subject must be taken again, and that no subject depending upon this one may be taken until the E is removed. In removing an E the student must take the subject again either at a regular period or under conditions approved in writing and in advance by the head of the department.

Three hours of laboratory or of drawing are regarded as the equivalent of one lecture or recitation hour.

In case a student fails to complete his work in any subject the instructor may, at his discretion, report to the office not a D but an "Incomplete", which shall be designated by the letters "Inc." This is not regarded as a condition, but it becomes an E at the beginning of the next school year unless previously removed, or unless an extension of time is given in writing by the instructor in charge.

In case a student leaves school with one or more conditions and returns after an absence of a year or more, the term "next school year" will be interpreted to mean the next school year of his attendance; but in case he leaves at the close of the first semester he may return at a similar period a year or more later, subject to the conditions under which he left, as though there had been no break in his attendance, except in case of a changed curriculum.

No student may take any junior subject until he has received credit in all freshman subjects; and no student may take any senior subject until he has received credit in all freshman and sophomore subjects. In the case of students admitted to advanced standing, this rule is suspended during the first year of their attendance.

THE LIBRARY

The school library occupies one-half of the second floor of Guggenheim Hall. The room is well lighted and ventilated and has a seating capacity for one hundred twenty readers. The library contains about fourteen thousand volumes and several hundred pamphlets, principally of a technical nature, and is being increased in subjects corresponding to instruction given in the school. Direct access to the shelves is permitted to all students in order that they may obtain the benefit of examining the books themselves. Books which are not needed for special reference work are loaned for home use for a period of two weeks. The card catalogue includes entries under author, title, and subject, arranged on the dictionary plan. The classification is an adaptation of the Dewey decimal system to the needs of a technical library.

The library subscribes to the publications of the leading scientific societies of the world and to the chief literary and scientific periodicals. It is especially rich in files of engineering journals, the material in which is available for ready reference through excellent periodical indexes received monthly. The library is a depository for the documents of the United States Geological Survey and has an unusually complete collection of the publications issued by state geological surveys and mining bureaus both in this country and abroad. A collection of mine reports has recently been indexed and made available for reference.

During the academic year the library is open from 8 a. m. to 12:30 p. m.; from 1:30 p. m. to 5 p. m., and from 7 p. m. to 9:30 p. m., except on Saturdays and holidays On Saturdays the library is closed in the afternoon.

Y. M. C. A.

The Colorado School of Mines Young Men's Christian Association was one of 770 Student Associations in the colleges, universities, normal, professional, and preparatory schools of the United States and Canada, March 14, 1916. Five hundred and eighty-five of these institutions reported 204,182 young men enrolled as students on the above date, and of this number 75,091 were members of the College Young Men's Christian Associations.

The Y. M. C. A. of the Colorado School of Mines exists for the purpose of serving the men of the school in every possible way. When called upon to do so, the Association assists men in securing suitable boarding and rooming accommodations, and when possible, in securing employment to help them earn their expenses through school. Weekly Bible Study Classes and religious meetings are conducted during the greater part of the year.

The "Mines Hand Book" is published annually and distributed free of charge to students, faculty, alumni, and prospective students. It contains useful information concerning the school, Golden, and vicinity. A copy of this book will be sent, on application to the Secretary of the Association.

An Advisory Board, consisting of one alumnus, one local minister, one local business man, and two faculty members supervises the work of the Association. The present board members are: Professor Horace B. Patton, Professor George E. F. Sherwood, Rev. George E. Keithley, Mr. George W. Parfet, and Mr. Clare L. Colburn.

The officers for 1916-1917 are: President, **F. E. O'Neill, '18**; Vice-president, **R. M. Weaver, '17**; Secretary, **Wilbur Crispelle, '19**; Treasurer, **W. B. Tongue, '18**; General Secretary, **J. Merrel Parker, University of North Carolina, '16.**

Y. M. C. A. SPEAKERS, 1916

DR. H. F. HALL.....Denver, Colo.
"What Must I Do"

IRA E. LUTE.....Denver, Colo.
"Y. M. C. A. Work"

DEAN HART .....Denver, Colo.
"The Way of Salvation"

DR. F. T. BAYLEY.....Denver, Colo.
"Dynamite and the Reign of Peace"

DR. C. L. MEAD.....Denver, Colo.
"The Danger of the Fractional"

DR. LIVINGSTON FARRAND.....Boulder, Colo.
"The Other Man's Point of View"

BISHOP F. P. McCONNELL.....Denver, Colo.
"Keeping Oriented"

DR. W. B. PHILLIPS.....Austin, Texas
"Religious Life in the School of Mines"

JUDGE FREEMAN .....Denver, Colo.
"A Business Man's Religion"

HON. CLARENCE P. DODGE.....Colorado Springs, Colo.
"Christianity and the Present Crisis"

C. L. JOHNSON.....Denver, Colo.
"China and the Future"

DAVID A. LATSHAW.....New York City
"The Need of Christ"

PROF. W. J. HAZARD.....Golden, Colo.
"Early History of the Mines Y. M. C. A."

H. L. HEINZMAN.....Kankakee, Ill.
"Sidelights on the European War"

DR. WINFIELD SCOTT HALL.....Northwestern University
"Sex Hygiene"

THE INTEGRAL CLUB

The Club Room is in the Gymnasium Building and is furnished in the ordinary style of a gentleman's club. The purpose of the Club is to foster good comradeship among the students. It is under the direct control and management of a student committee:

R. M. Weaver, '17, Chairman
F. E. O'Neill, '18
Carleton Richardson, '19

PRIZES

Each year, usually at commencement, prizes are awarded to certain students who have maintained an excellent scholastic record or who have submitted a meritorious thesis. These prizes may be in the form of cash, engineering instruments, or books. At the commencement exercises, May 26, 1916, the Brunton Transit, presented by David W. Brunton, of Denver, Colorado, was awarded to Walter H. Ralph and William M. Traver, Jr., for their thesis entitled, "Driving a Tunnel Through Mt. Zion."

SCIENTIFIC SOCIETY

The Scientific Society has for its object the presentation and discussion of technical and engineering subjects. From time to time, lectures are delivered before the Society by leading authorities on various topics of interest to its members and friends. The selection of these speakers is placed in the hands of an executive committee chosen from the senior and junior classes. All lectures are held in Simon Guggenheim Hall, on such nights as are most convenient for the majority of the students. The proceedings of the Society are printed in "The Colorado School of Mines Magazine." The alumni, faculty, senior, and junior classes of the institution constitute the active members of the organization; the sophomores and freshmen are associates.

The officers for the year 1916-17 are:

C. M. Knepper, '17.....President
H. E. Munn, '17.....Vice-president
L. Ehnbom, '17.....Secretary
L. M. Reith, '18.....Treasurer

SOCIAL LIFE

Social life in the school is fostered by a committee of students which consists of the presidents of the four undergraduate classes of the school. The president of the senior class is chairman of this committee. Receptions are given at intervals. The committee for 1916-17 is:

Mearle G. Heitzman, '17
Henry G. Schneider, '18
Loren D. Mulford, '19
George V. Dunn, '20

LOAN FUNDS

The following loan funds have been established to assist worthy and deserving students through school.

The Natalie H. Hammond Loan Fund of $1,000.00 was donated to the school in July, 1909, by Mr. John Hays Hammond.

The Vinson Walsh Loan Fund of $1,000.00 was donated to the school in May, 1908, by Mr. Thomas F. Walsh, in memory of his son Vinson Walsh.

The Walter Lowrie Hoyt Loan Fund of $2,000.00 was donated to the school in May, 1912, by Mrs. Mattie B. Hoyt, in memory of her husband, Walter L. Hoyt.

Thirty-five students have received financial assistance from these funds.

UNITED STATES BUREAU OF MINES

Under the terms of an agreement made between the Director of the Bureau of Mines and the Board of Trustees of the Colorado School of Mines, the Colorado office of the bureau has been transferred from Denver to Golden. Plans for co-operation between the bureau and the school have been made and active work is in progress.

EXTENSION WORK

Extension educational work in the coal and metal mines is carried on by the school under the direction of Professor J. C. Roberts, of the Department of Safety Engineering. The extension courses include instruction in english, arithmetic, grammar, civil government, handling explosives, ventilation, sanitation, prevention of accidents, and first aid to the injured.

DEPARTMENT OF ATHLETICS AND PHYSICAL TRAINING

By virtue of the athletic fee required, all students entering the School of Mines become members of the Athletic Association.

The Association is supported by the student fees, gate receipts, and by contributions from the alumni and other friends of the school.

The affairs of the Association are managed by a Board of Control, which consists of: the Athletic Director, Mr. F. G. Carter, Chairman; the captains of the football, baseball, basketball, and track teams; and the presidents of the junior and senior classes.

The Athletic Association maintains an office in the Gymnasium Building, under the supervision of the athletic director.

Opportunity is offered for systematic physical development of the student under the instruction of E. J. Allmendinger, trainer, who will conduct regular classes.

ALUMNI ASSOCIATION

The aim of the Alumni Association is to promote acquaintance and friendship among the graduates, to encourage them to aid each other, and to make an organized effort to elevate and uphold the reputation and standard of their Alma Mater. To carry out these ideas, the Association, under the management of an Assistant Secretary and Treasurer, publishes monthly "The Colorado School of Mines Magazine" and conducts an employment bureau, or Capability Exchange, for the benefit of the members. This employment bureau also assists undergraduate students in securing employment during summer vacations and at other times, especially when such students are in need of funds to defray the cost of their education.

All graduates are earnestly requested to join the Association, and to keep the assistant secretary and treasurer advised of their addresses and occupations.

The officers of the Association are:

Harry J. Wolf, '03.....President
Frederick C. Steinhauer, '99.....Vice-President
John Gross, '97.....Secretary
Sidney B. Tyler, '99.....Treasurer
Executive Committee—William B. Milliken, '93;
Russell B. Paul, '02; Daniel Harrington, '00
Orville Harrington, '98....Asst. Sec'y and Treas.
Editor and Manager Colorado School of Mines Magazine
Manager of Capability Exchange

The Association holds its annual meeting and banquet on the day following the commencement exercises, unless otherwise provided for by the Executive Committee. All graduates are eligible to membership and are invited to the annual meeting and to the banquet.

MONTANA CHAPTER OF THE ALUMNI ASSOCIATION, BUTTE, MONTANA

A. S. Richardson, '12.....President
W. C. Douglas, '11.....Vice-President
Ross R. May, '12.....Secretary-Treasurer

UTAH CHAPTER OF THE ALUMNI ASSOCIATION, SALT LAKE CITY, UTAH

James S. Thompson, '99.....President
Blair S. Sackett, '09.....Vice-President
A. C. Watts, '02.....Secretary-Treasurer

ENROLLMENT OF STUDENTS

CLASS OF 1917

SENIOR CLASS

President, Mearle G. Heitzman
Vice-President, John H. Winchell, Jr.
Secretary, Harry A. Robinson
Treasurer, Thaddeus H. Andrews
Editor, Kenneth S. Ferguson

Andrews, Thaddeus H.....Walsenburg, Colo.
Boot, Harry E.....Denver, Colo.
Butler, Mifflin M.....Denver, Colo.
Chan, Albert K.....San Francisco, Calif.
Cheney, George M.....Golden, Colo.
A. B. Williams College
Chiang, Y. K.....An-Yo Hsien, China
Ehnbom, Lincoln.....Denver, Colo.
Eisele, Lewis G.....Colorado Springs, Colo.
Ferguson, Kenneth S.....Denver, Colo.
Goldfain, George.....Denver, Colo.
Heitzman, Mearle G.....Denver, Colo.
Higgins, Robert.....Pueblo, Colo.
Hofius, Max T.....Belize, British Honduras, C. A.
Hsueh, K. L.....Kiangsu, China
Knepper, Chester M.....Somerset, Pa.
Graduate, U. S. Naval Academy
Komar, George.....London, England
Levis, Alfred C.....Baltimore, Md.
Maxwell, Norman E.....Silverton, Colo.
Mewhirter, Sydney A.....Pueblo, Colo.
Miller, Alvah L.....Brooklyn, N. Y.
Munn, Harold E.....Golden, Colo.
Murphy, William J.....Springfield, Mass.
Nufio, Gustavo A.....Teguciagalpa, Honduras, C. A.
Oliveros, Reginald P.....Savannah, Ga.
Robinson, Harry A.....Lawrence, Mass.
Roll, George H.....Ellsworth, Minn.
Schoensiegel, Albert D.....Denver, Colo.
Sealey, Fred C.....Denver, Colo.
Small, Sidney S.....Denver, Colo.
Thurstin, Robert A.....Bowling Green, Ohio
B. S. Kenyon College
Van Burgh, Lisle R.....Denver, Colo.
Winchell, John H. Jr.....Denver, Colo.
Worth, Lee K.....Colorado Springs, Colo.
Yuan, P. C.....Fu-Chan, China

CLASS OF 1918

JUNIOR CLASS

President, Henry G. Schneider
Vice-President, Walter T. O'Reilly
Secretary, Earl J. Dickinson
Treasurer, Norman R. Copeland
Editor, David R. Locke

Albi, Charles.....Denver, Colo.
Allan, T. H.....Denver, Colo.
Beyrle, Charles N.....Los Angeles, Calif.
Buck, Luther J.....Emporia, Kans
Buckley, Howard G.....Marietta, Ohio
Charles, William O.....Golden, Colo.
Chiang, L. C.....Fu Kien, China
Clifford, John J.....Edgewater, Colo.
Copeland, Norman R.....Denver, Colo.
Crispelle, Wilbur.....Leadville, Colo.
Dickinson, Earl J.....Denver, Colo.
Gibson, Robert W.....Chattanooga, Tenn.
Jones, William F.....Rock Springs, Wyo.
Kinsley, Arthur C.....Colorado Springs, Colo.
Krier, Edward J.....Walsenburg, Colo.
Locke, David R.....San Antonio, Texas
Maxson, Harold F.....Los Angeles, Calif.
Mayhugh, Dorsey E.....Pueblo, Colo.
O'Malley, John J.....Albany, Mo.
O'Neill, Frank E.....Crozet, Va.
A. B. Richmond College
O'Reilly, Walter T.....Denver, Colo.
Putnam, Webster F.....Denver, Colo.
Rabb, John H., Jr.....St. Paul, Minn.
Reith, Lindley M.....Woodland, Calif.
Reynolds, Karl W.....Denver, Colo.
Riddle, Donald D.....Golden, Colo.
Robertson, Fitch.....Pueblo, Colo.
Robinson, Edward W.....Denver, Colo.
Schneider, Henry G.....Denver, Colo.
Shrewsbury, Talbot Q.....Washington, D. C.
Stouder, Robert D.....Denver, Colo.
Teets, Charles W.....Red Cliff, Colo.
Tongue, Walter B., Jr.....Poughkeepsie, N. Y.
Tsen, B. C.....Hunan, China
Weaver, Ralph M, Jr.....New York City
White, Charles W.....Birmingham, Ala.
White, Roger F.....Golden, Colo.
Williams, William H.....Denver, Colo.
Young, Guy K.....Spokane, Wash.

CLASS OF 1919

SOPHOMORE CLASS

President, Loren D. Mulford
Vice-President, Earl L. Bilheimer
Secretary, Guy E. Miller
Treasurer, Guy E. Miller
Editor, Iestyn M. Charles

Bilheimer, Earl L. ..... Bath, Penn.
Bird, Lee W. ..... North Platte, Nebr.
Breckenridge, Leland D. ..... Fort Worth, Texas
Brown, Frank A. ..... Colorado Springs, Colo.
Carr, Raymond M. ..... Golden, Colo.
Chao, Yuan Chen ..... Kansu, China
Charles, Iestyn M. ..... Golden, Colo.
Conley, William A. ..... Douglas, Arizona
Coulter, Ronald S. ..... Golden, Colo.
Cunningham, Samuel D. ..... Silverton, Colo.
Dyson, John M. C. ..... Washington, D. C.
Ehorn, Fred F. ..... Denver, Colo.
Fulenwider, Harold G. ..... Denver, Colo.
Fushey, Jesse J. ..... Meriden, Conn.
Griffen, John D. M. ..... Port Chester, N. Y.
Huleatt, William P. ..... Chicago, Ill.
Johnson, George T. ..... Denver, Colo.
Jones, Allan B. ..... Denver, Colo.
Jones, David L. ..... Denver, Colo.
Kiesel, Albert H. ..... Ouray, Colo.
Krepps, Randolph ..... Green Mountain Falls, Colo.
Mahoney, John J. ..... Denver, Colo.
McCarty, Merrill H. ..... Reliance, Wyo.
Mechin, Rene J. ..... St. Louis, Mo.
Metzger, Otto H. ..... Meeker, Colo.
Miller, Guy E. ..... Canon City, Colo.
Mulford, Loren D. ..... Golden, Colo.
Parker, Russell J. ..... Denver, Colo.
Payne, Goodman B. ..... Denver, Colo.
Peterson, Clarence E. ..... Denver, Colo.
Pfrimmer, Walter S. ..... Bloomington, Ind.
Poulin, John A. ..... Naturita, Colo.
Prommel, Harold W. C. ..... Golden, Colo.
Richardson, Carleton ..... Golden, Colo.
Romine, Thomas B. ..... Walla Walla, Wash.
Rutledge, Walton G. ..... McAlester, Okla.
Scheutzow, George A. ..... Oswego, N. Y.
Schneider, Charles M. ..... Colorado Springs, Colo.
Stringham, William S. ..... Denver, Colo.
Sundquist, Theodore L. ..... Alamosa, Colo.
Tiffany, Emory M. ..... Durango, Colo.
Townsend, Albert ..... Golden, Colo.
Tseng, Yin L. ..... Blinjoe, Banka, East Indies
Wahler, Joseph A. ..... Denver, Colo.

CLASS OF 1920

FRESHMAN CLASS

President, George V. Dunn
Vice-President, Joseph L. Turre
Secretary, Ninetta A. Davis
Treasurer, Earl B. Hardy
Editor, Fred L. Serviss

Alexander, Edwin D. ..... Dallas, Texas
Baer, Charles F. ..... Steamboat Springs, Colo.
Bailey, Donald L. ..... Denver, Colo.
Baldwin, Harry L. ..... Denver, Colo.
Beaton, Bruce S. ..... Denver, Colo.
Bell, Francis M. ..... Palisade, Colo.
Benbow, Jules C. ..... Colorado Springs, Colo.
Berkovitz, Sam ..... Pueblo, Colo.
Bilisoly, Joseph M. ..... Golden, Colo.
Bilisoly, Walter E. ..... Golden, Colo.
Boeké, Charles L. ..... Lena, Ill.
Bond, Frank C. ..... Estes Park, Colo.
Brockman, Cecil C. ..... Bickleton, Wash.
Brown, Prentice F. ..... Denver, Colo.
Bunte, Ernest B. ..... Denver, Colo.
Burwell, Blair, Jr. ..... Denver, Colo.
Case, William B. ..... Denver, Colo.
Casey, James W., Jr. ..... Denver, Colo.
Christison, Wilburn E. ..... Canon City, Colo.
Clark, James A. ..... Denver, Colo.
Clifford, Thomas J. ..... Edgewater, Colo.
Clough, Richard H. ..... Colorado Springs, Colo.
Cole, George J. ..... Olean, N. Y.
Creeth, Burgess F. ..... Hastings, Nebr.
Davis, Ninetta A. ..... Denver, Colo.
Dunn, George V. ..... Golden, Colo.
Dutton, Dewey A. ..... Rifle, Colo.
Fahlstrom, Nels ..... Oland, Sweden
Fast, Joseph B. ..... Chicago, Ill.
Fegan, Thomas D. ..... Victoria, Texas
Ferguson, Dewitt R. ..... Pueblo, Colo.
Fessenden, John H., Jr. ..... Tampa, Fla.
Flint, Howard T. ..... Denver, Colo.
Galloway, James V. ..... Norwood, Colo.
Gallucci, Nicholas ..... Louisville, Colo.
Garnett, Samuel A. ..... Pueblo, Colo.
Gifford, Donald W. ..... Norwood, Colo.
Goodrich, Lyman L. ..... Watertown, N. Y.
Graham, David J. ..... Nishawaka, Ind.
Grimm, Theodore H. ..... Warren, Ohio
Hamilton, Percy L. ..... Craig, Colo.
Hardy, Earl B. ..... Watertown, N. Y.

Hay, George, Jr. ..... Coshocton, Ohio
Hill, Tom B. ..... Cripple Creek, Colo.
Houssels, John K. ..... Long Beach, Calif.
Hunter, Carl A. ..... Hot Springs, S. D.
Irland, Burrall H. ..... Webster Groves, Mo.
Jennings, Edward B. ..... Salt Lake City, Utah
Johnson, Roscoe P. ..... Brighton, Colo.
Johnston, David C. ..... Nashville, Tenn.
Keach, Harold G. ..... Fort Worth, Texas
Keyser, Roland W. ..... Woodsville, N. H.
Kimball, Neil W. ..... Craig, Colo.
Kirkwood, David N. ..... Antofagasta, Chile, S. A.
Klamann, Albert A. ..... Denver, Colo.
Lee, Edwin H. N. ..... Cheyenne, Wyo.
LeVeque, Earl M. F. ..... Boulder, Colo.
Levings, William S. ..... Leadville, Colo.
Lichtenheld, Fred A. ..... Denver, Colo.
Linderholm, Carl T. ..... Alamosa, Colo.
Linn, Herbert K. ..... Denver, Colo.
Matthews, William D. ..... Salida, Colo.
Mee, John ..... Denver, Colo.
Menke, Paul T. ..... Golden, Colo.
Miller, Harold ..... Youngstown, Ohio
Milliken, John T., Jr. ..... St. Louis, Mo.
Payne, Samuel G. ..... Denver, Colo.
Pope, Loverne A. ..... Hastings, Nebr.
Porter, George J. ..... Denver, Colo.
Pratley, Henry H. ..... Denver, Colo.
Richert, George L. ..... Denver, Colo.
Safe, Arthur E. ..... Aspen, Colo.
Scott, Carroll T. ..... Berkeley, Calif.
Scott, William A. ..... Denver, Colo.
Serviss, Fred L. F. ..... Golden, Colo.
Simson, George, Jr. ..... Long Beach, Calif.
Sisson, Myron L. ..... Wray, Colo.
Smith, Claude H. ..... Holyoke, Mass.
Snodgrass, Glenn R. ..... Manning, W. Va.
Spezia, Charles A. ..... Clifton, Ariz.
Spezia, Louis J. ..... Clifton, Ariz.
Tanner, Horace A. ..... Golden, Colo.
Thomas, George D. ..... Lafayette, Colo.
Tost, Jacob F. ..... Ridge, Colo.
Turre, George J. ..... Denver, Colo.
Turre, Joseph L. ..... Denver, Colo.
Van Gilder, Charles P. ..... Morristown, N. J.
Wailes, Ronald D. ..... Eaton, Colo.
Waller, Hans J. ..... Golden, Colo.
West, Harold W. ..... Rocky Ford, Colo.
White, John W. ..... Sutherland, Nebr.
Wichmann, E. C. Lothar ..... Telluride, Colo.
Witte, Hermann G. ..... Hamburg, Germany
Woltzen, Lloyd J. ..... Castle Rock, Colo.

SUMMARY

Seniors	34
Juniors	39
Sophomores	44
Freshmen	94
Total	211

GEOGRAPHICAL DISTRIBUTION

Colorado	127	Massachusetts	3
New York	8	Washington	3
California	7	Wyoming	3
Ohio	5	Indiana	2
Texas	5	Minnesota	2
Missouri	4	Pennsylvania	2
Nebraska	4	Tennessee	2
Arizona	3	All other states	14
Illinois	3	Foreign Countries	14
		Total	211

CLASS OF PROSPECTORS

1916

Angell, Charles H.....Denver, Colo.
Bach, Robert .....Denver, Colo.
Bild, Charley G.....Twin Lakes, Colo.
Brennan, Edward.....Seattle, Wash.
Browne, Jim .....Denver, Colo.
Carnell, Charles C.....La Plata, Colo.
Copeland, L. A.....Golden, Colo.
Cunningham, Mame .....Georgetown, Colo.
Curry, H. T.....Golden, Colo.
Curtis, Harry B.....Denver, Colo.
Davison, Elizabeth M.....Golden, Colo.
de Berard, Niletta C.....Granby, Colo.
de Berard, Willis N.....Granby, Colo.
De Vine, Elsie F.....Greeley, Colo.
Du Pont, Charles I.....Denver, Colo.
Greenison, Theodore .....Glenrock, Wyo.
Grimm, Theodore H.....Warren, Ohio
Hetherington, T. J.....Colorado City, Colo.
Horlacker, Chas. W.....Denver, Colo.
Jeuck, Earl Joseph.....Golden, Colo.
Kelly, Chas. E.....Mancos, Colo.
Killgore, Robert J.....Denver, Colo.
Kingsbury, James D.....Denver, Colo.
Kittinger, Clarence S.....Denver, Colo.
Lewis, Robert N.....Central City, Colo.
Moscript, George W.....Idaho Springs, Colo.
Miller, L. L.....Denver, Colo.
Olin, Clare D.....Pueblo, Colo.
Owens, Charles A.....Golden, Colo.
Patten, Frank J.....Denver, Colo.
Peters, Erwin H.....Detroit, Mich.
Robertson, David.....Dawson, Y. T.
Ryan, Philip .....Boulder, Colo.
Servant, Robert .....Golden, Colo.
Soderstrom, E. W.....Golden, Colo.
Stanley, Jesse M.....Emmett, Idaho
Stone, Sam.....Granby, Colo.
Sutton, Charles A.....Denver, Colo.
Wade, Chas. T.....Buena Vista, Colo.
Wilcox, Hawley C.....Breckenridge, Colo.
Wilder, Merion M.....Red Cliff, Colo.
Wilson, Allie C.....Denver, Colo.
Winzeler, George .....Tremont, Ill.
Wood, John W.....Monte Vista, Colo.
Young, D. S.....Denver, Colo.

ALUMNI

Abel, Walter D., '06
Supt. Three R. Mines, Patagonia, Ariz.
Adami, Charles J., '99
Gen. Supt. St. Joseph Lead Co.
Gen. Mgr. Doe Run Lead Co., Bonne Terre, Mo.
Adams, Charles, '04
Adams, Wilbur E., '00, Deceased
Ailinger, Walter J., '13
Mining Engineer, Goldroad, Ariz.
Aldrich, Harold W., '06
Supt. of Leaching Plant, Anaconda Copper Mining Co., Anaconda, Mont.
Allen, Carl A., '05
Allen & Colburn, Mining Engineers, Denver, Colo.
Allen, Maynard C., '06
Engineer, St. Joseph Lead Co., Bonne Terre, Mo.
Aller, Frank D., '92
Agent, A S. & R. Co., Antofagasta, Chile, S. A.
Ambrosius, C. E., '88
Mining Engineer, Guanajuato, Mexico
Anderson, Axel E., '04
Technical Division, E. I. du Pont de Nemours & Co., Denver, Colo.
Anderson, Neil A., '02
U. S. Deputy Mineral Surveyor, Thornton, Idaho
Andre, Morris V., Jr., '11
Cyanide and Flotation Metallurgist, Portland Gold Mining Co., Victor, Colo.
Andrews, Earle D., '12
Salesman, Iowa Pub. Co., Davenport, Iowa
Arfsten, George J., '13
Mill Foreman, Jessie Cons. M. Co., Breckenridge, Colo.
Armingtin, H. C., '07
Mining Engineer, Los Angeles, Calif.
Arthur, Charles S., '13
Consulting and Safety Engineer, Denver, Colo.
Arthur, Edward P., Jr., '95
U. S. Mineral Surveyor, Cripple Creek, Colo.
Atkins, Horace H., Jr., '94
Mgr. Prairie Oil & Gas Co., Muskogee, Okla.
Atkinson, W. J., '96
Atwater, Maxwell W., '01
Mgr. Zinc Concentrator, Basin, Mont.
Austin, Arthur, '05, Deceased
Badger, Herbert E., '02
Greeley, Colo.
Badgley, Charles W., '06
Metallurgical Engineer, Smelting Works, El Paso, Texas
Bailey, E. W., '05
Mining Engineer, Denver, Colo.
Baker, Erwin F., '14
Mining Engineer, Denver, Colo.

Baker, Hamilton W., '11
Mining Engineer, Cornucopia, Ore.
Ball, Byron E., '13
T. C. I. & R. R. Co., Birmingham, Ala.
Ball, Louis R., '00
Professor of Military Science and Tactics, Throop College of Technology, Pasadena, Calif.
Ball, Max W., '06
U. S. Bureau of Mines, Washington, D. C.
Ballagh, J. Courtenay, '10
Gen. Mgr., Southwestern Wrecking Co., El Paso, Texas
Banks, Leon N., '12
Mining Engineer, Denver, Colo.
Barbour, Percy P., '98
Mining Engineer, Stevens, Barbour & Co., Idaho Springs, Colo.
Barenscheer, William J., '96
Barker, Franklin L., '06
Professor, Government University, Tientsin, China
Barker, Pierce, '07
New Reduction Works, Anaconda Copper M. Co., Anaconda, Mont.
Barnes, Corrin, '96
Mining Engineer, Goldfield, Nev.
Barnett, Walter W., '11
Seoul Mining Co., Holkol, Chosen, Korea
Barney, H. A., '14
Mining Engineer, Canca, Colombia, S. A.
Barron, Chauncey T., '02
Compania Metallurgica Mexicana, San Luis Potosi, Mexico
Bartholomew, Tracy, '06
Mgr. Rico Tropical Fruit Co., Carrochales, Porto Rico
Bastanchury, G. A., 07
Fullerton, Calif.
Beall, Alpheus B., Jr., '15
Mining Engineer, Iron Mountain, Mich.
Bebee, Alfred H., '15
Mining Engineer, Cripple Creek, Colo.
Beck, Daniel L., '12
Mining Engineer, Smuggler, Colo.
Beck, W. Lloyd, '14
Head Sampler, Cananca Cons. Copper Co., Sonora, Mexico
Beeler, Henry C., '96
Mining Engineer, Denver, Colo.
Bell, Charles N., '06
Gen. Supt., Smuggler Union M. Co., Telluride, Colo.
Bellam, Henry L., '89
Assayer, Reno, Nevada
Benjovsky, T. D., '09
Mine Supt., U. S. Gold Corporation, Sugar Loaf, Colo.
Benwell, George A., Jr., '00, Deceased
Benner, Howard C., '13
Highland Boy Mine, Bingham, Utah
Bergh, John E., '02
Mining Engineer, Salt Lake City, Utah
Berry, Albert, '05
Supt., Bridgeport Land Co., Bridgeport, Wash.
Berthier, Ulysses H., '16
Testing Dept., International Smelt. Co., Tooele, Utah
Berthoud, Capt. E. L., '00, (Hon.) Deceased

Bertschy, Perry H., '98
Marysville, Mont.
Bicknell, Harold L., '16
Furnace Operator, Snyder Electric Furnace Co., Chicago, Ill.
Bigley, Arthur C., '16
Engineering Dept., Anaconda Cop. M. Co., Butte, Mont.
Billyard, John R. H. H., '13
Efficiency Engineer, Two Rivers, Wis.
Bishop, Raymond, '01, Deceased
Bisland, John B., '13, Deceased
Blackburn, Ward, '08
Ingersol-Rand Co., Los Angeles, Calif.
Blaurock, Carl A., '16
Gold & Silver Refining, Denver, Colo.
Block, Gary E., '08
Engineer, Ellsworth-Klanor Construction Co., Pittsburg, Kas.
Blow, A. A., (Hon.) '01
Belleville, Va.
Blum, Sidney, '11
Assayer and Chemist, A. R. & R. Co., Omaha, Neb.
Blumenthal, Emil E., '98
Granite Bimetallic Co., Phillipsburg, Mont.
Bolan, Albert E., '15
Illinois Mining Co., Gold Hill, Colo.
Bowie, James W., '94, Deceased
Bowhay, Arnold A. Jr., '14
Instructor, High School, Reno, Nev.
Bowman, Frank C., '01
Gen. Mgr. New Reliance G. M. Co., Trojan, S. D.
Bowman, Reginald G., '11
Chief of Research Dept., International Smelt. Co., Tooele, Utah
Boyd, Jesse T., '08
Supt. Empire Zinc Co., Mines, Red Cliff & Gilman, Colo.
Boyle, Willis J., '12
Los Angeles, Calif.
Bradford, Albert H., '09
Placentia, Calif.
Bradford, Julius S., '10
Gen. Supt. Chiksan M. Co., Chosen, Korea
Bradley, Joseph N., '01
Florence, Colo.
Brandow, Glenn A., '15
Butte, Mont.
Brandt, A. R., '07
Denver, Colo.
Breed, Charles F., '01
Chicago, Ill.
Bregman, Adolph, '14
Draftsman, Nichols Copper Co., New York City
Brenneman, Fred G., '16
Pottsville, Pa.
Briber, Frank E., '16
Engineering Office, Utah Cons. Min. Co., Bingham, Utah
Brinker, Arthur C., '01
Gen. Mgr., Buena Terra Min. Co., El Paso, Texas
Brinker, Albert W., '08, Deceased
Bronstein, Chas. N., '13
Tooele, Utah

Brooke, Lionel, '14
Morococha Mining Co., Peru, S. A.
Brooks, Eugene C., '09
Cambridge, Mass.
Brousseau, A. Ringgold, '14
Golden Tungsten Production Co., Boulder, Colo.
Brown, C. Leroy, 08
Supt. Colorado Tungsten Co., Sugar Loaf, Colo.
Brown, John B., '06
Canadian Allis-Chalmers Ltd., Toronto, Can.
Brown, Norton H., '92
Gen. Supt. Topeka Cons. Mines Co.
Gen. Supt. Frontenac Cons. Mines. Ltd., Central City, Colo.
Brown, R. L., '05
Professor of Mining & Geology, Ala. Polytechnic Inst., Auburn, Ala.
Brown, Samuel R., '11
Mill Supt., Plymouth Cons. Gold Mines, Ltd., Plymouth, Calif.
Brown, Walter R., '10
Min. Engr., Nev. Cons. Copper Co., Ruth, Nev.
Bruce, Harry F., '00
Supt., Spearhead Gold Mining Co., Goldfield, Nev.
Bruce, James L., '01
Mgr. Butte & Superior Mining Co., Butte, Mont.
Bruce, Stuart S., '99
Bruderlin, Emil J., '10
Ohio & Colo. Smelting Co., Salida, Colo.
Brugger, Melvin, '14
Head Sampler, Ariz. Copper Co., Metcalf, Ariz.
Brunel, Frank P., '12
Chemist, Ajo Cons. Copper Co.
Consulting Engr., South Cornelia Copper Co.
Mitchell & Brunel, Cons. Min. Engrs. & Brokers, Ajo, Ariz.
Brunel, Rene L., '06
Golden, Colo.
Bryan, Russell R., '08
Efficiency Engineer, Quincy Mining Co., Hancock, Mich.
Bucher, John W., '02
Chief Engineer, Colo. Iron Works, Denver, Colo.
Buck, Arthur H., '97
Supt. Iron Age Mine, Boulder, Colo.
Budrow, William B., '92
Min. Eng., Guadalajara, Jalisco, Mexico
Buell, Arthur W., '08
Fort Smith, Ark.
Bulkley, Frank, (Hon.) '98
Min. Engr., Denver, Colo.
Bumsted, Edward J., '01
Crown King, Ariz.
Bunger, Milne E., '09
Denver, Colo.
Burgess, Chas. W., '09
Gen. Supt., Baltic Mines of Missouri, Lead City, Mo.
Burlingame, Walter E., '01
Chemist and Assayer, Denver, Colo.
Burns, Jay J., '16
Butte & Superior Copper Co., Butte, Mont.
Burris, Samuel J., Jr., '15
Experimental Work, Valley View Cons. G. M. Co., Hesperus, Colo.

Busey, A. P., Jr., '05
Gen. Mgr., Penn. Mining Co., Campo Seco, Calif.
Bussey, Edwin E., '97
Mine Boss, Alaska-Juneau M. Co.. Juneau, Alaska
Butler, G. Montague, '02
Dean, College of Mines and Engineering, Univ. of Arizona, Tucson, Ariz.
Butner, Daniel W., '15
Tucson, Ariz.
Cadot, John J., '15
Flotation Operator, Ariz. Copper Co., Morenci. Ariz.
Cain, Louis S., '13
Engineer, Department of Public Works, Honolulu. T. H.
Callahan, Thos W., '14
Construction Engineer, Victorville, Calif.
Calvert, Clarence E., '12
Butte, Mont.
Campbell, Kent P., '10
Chemist, A. S. & R. Co., Sasco, Ariz.
Canning, Herbert A., '97, Deceased
Canning, Walter E., '09
Anyox, B. C., Canada
Carlson, Monroe O., '15
Engineer, Utah Fuel Co., Castle Gate, Utah
Carman, John B., '10
El Paso, Texas
Carney, Hugh J., '04
Ouray, Colo.
Carpenter, Cranston H., '09
Chief Chemist, Utah Copper Co., Garfield, Utah
Carpenter, Paul H., 10
Ohio Copper Co., Lark, Utah
Carper, Armistead F., '14
Supt. Sun Dial G. M. Co., Oatman, Ariz.
Carstarphen, F. C., '05
Tramway Engineer, American Steel & Wire Co., Trenton, N. J.
Cary, Webster P., '10
General Engineering Co., Salt Lake City, Utah
Chamberlin, W. O., '05
Landscape Architect, Denver, Colo.
Chandler, John W., Jr., '01, Deceased
Chapman, Irving A., '13
Butte, Mont.
Chapman, Thomas L., '06
South American Dev. Co., Guayaquil, Ecuador, S. A.
Charles, Lavern J., '02
Construction Engineer, U. S. Reclamation Service, Elephant Butte, N. M.
Chatin, August H., '16
Anaconda Copper Co., Butte, Mont.
Chedsey, William R., '08
Denver, Colo.
Chen, Fan, '16
Shanghai, China
Chen, Ye-Fah, '14
Pinghsiang Colliery, Pinghsiang, China
Cheng, Dah-Chun, '14
Shanghai, China
Christensen, Walter, '02

Church, Myron J., '98, Deceased
Clapp, Leroy P., '09
Melbourne, Australia
Clark, George B., '01
Assayer and Chemist, River Smelt. & Ref. Co., Florence, Colo.
Clark, Louis F., 14
Chemist, E. I. du Pont de Nemours & Co., Wilmington, Del.
Clark, Winfred N., '98
Supt. Ark. Valley Ry. Light & Power Co., Canon City, Colo.
Clausen, Samuel J., Jr., '11
Mexican Candelaria Co., San Francisco, Calif.
Cline, Seymour F., '08
Buyer, Hudson Motor Car Co., Detroit, Mich.
Coghill, Will H., '03
Professor of Metallurgy, Ore. School of Mines, Corvallis, Ore.
Cohen, Louis, '97
Mining Engineer, Denver, Colo.
Colburn, Clare L., '07
Allen & Colburn, Mining Engineers, Denver, Colo.
Cole, Burt, '92
Coleman, R. Prewitt, '03, Deceased
Colbran, Arthur H., '02
Mgr. Suan Mine, Pyeng Yang, Korea
Collins, Phillip M., '93
American Flotation Co., Silverton, Colo.
Collins, Shrive B., '01
Mining Engineer, Creede, Colo.
Comstock, Charles W., '90
Mining Engineer, Denver, Colo.
Copeland, Clarence, '11, Deceased
Corry, Arthur V., 98
Mining Engineer, Butte, Mont.
Corson, N. G., '07
Mining Engineer, Creede, Colo.
Cory, J. J., '05
Instructor, West Denver High School, Denver, Colo.
Cowperthwaite, Edward W., '13
Warren, Ariz.
Cox, Augustus D., '03
Consulting Engineer to G. B. Johnson Co., Reno, Nevada
Cox, W. Ray, '02
Mineral Inspector, Portland, Ore.
Craig, Allen E., '14
Timber Butte M. & M. Co., Butte, Mont.
Craigue, William H., '89
Cramer, Curtis P., '99
Santa Rita, N. M.
Crampton, Theodore H. M., '14
Supt. Smithsonite M. Co.,
Supt. Extension M. Co.,
Supt. Carbonate King M. Co.,
Operating Goodsprings Custom Assay Office, Goodsprings, Nevada
Cronin, Harry M., '13
Pearce, Ariz.
Crow, Wade L., '01, Deceased
Crowe, Thomas B., '00
Mill Supt. Victor Mill Dept., Portland G. M. Co., Victor, Colo.

Crutcher, Ernest R., 14
Supt. Leaching Dept., Zinc Plant, Anaconda Copper M. Co., Anaconda, Mont.
Cuno, A. F., '05, Deceased
Currens, Warren W., '12
Chemist, Ray Cons. Copper Co., Ray, Ariz.
Curtis, Roy P., '09
Chief Engineer, Spring Canyon Coal Co., Storrs, Utah
Daman, C. J., '13, Deceased
Dammann, Arthur Chester, '15
Solution Man, Aurora Cons. Mines Co., Aurora, Nev.
D'Arcy, R. L., '05
Oatman, Ariz.
Dauth, Herman, '13
Exploration Engineer, Tonopah Placers Co., Breckenridge, Colo.
Davenport, John, '12
Mill Supt. United Mineral Co., South Danbury, N. H.
Davey, William R., '98, Deceased
Davis, Carl R., '95
Gen. Mgr. Lancaster Gold M. Co., Ltd., Krugersdorp, Transvaal, S. Af.
Davis, Gilbert L., '99
U. S. Reclamation Service, Saco, Mont.
Davis, Gilmore Sherwin, '15
The O. L. Davis Lumber Co., Trinidad, Colo.
Davis, John R., '13
Shift Boss, Ernestine M. Co., Mogollon, N. M.
De Camp, W. Val, '08
Supt. Blue Bell Mine, Mayer, Ariz.
De Cou, Ralph E., '01
Cherry Creek, Nev.
De Sollar, Tenney C., '04
Chief Engineer, Quincy Mining Co., Hancock, Mich.
Dick, James E., '12
Mgr. Akron Mine, White Pine, Colo.
Divinney, George V., '03, Deceased
Dilts, Ira J., '08
Chemist and Engineer, U. S. Portland Cement Co., Concrete, Colo.
Dittus, Edward J., 11
Gen. Supt. Universal Mfg. & Sales Co., Crystal, Colo.
Dockery, L. A., '95, Deceased
Dodge, David C., '15
Assayer, Surveyor and Draftsman, Ed. Millard & Son, Ely, Nev.
Dollison, James E., '98
Surveyor and Proprietor, Alma Assay Office, Alma, Colo.
Douglas, William C., '11
Shift Boss, Jumbo Mine, Kennecott Copper Co., Kennecott, Alaska
Dove, Dean R., '13
Chief Chemist, Magna Plant, Utah Copper Co., Magna, Utah
Dow, William G., '06
Denver, Colo.
Downer, Roger H., '01
Downer Bros., Assayers & Chemists, Goldfield, Nev.
Downes, Frank A., '13
Assayer, Aurora Cons. Mines Co., Aurora, Nev.

Doyle, Donald B., '09
Mining Engineer, Congo, Africa
Draper, Marshall D., '97
Manager, Mina Mexico M. Co., Tonichi, Mexico
Drescher, Frank M., '00
Craig, Colo.
Dudgeon, James W., 13
Assayer and Chemist, Butte & Superior M. Co., Butte. Mont.
Duer, C. L., '05
Denver, Colo.
Duggleby, Alfred Francis, '15
Superintendent of Mines, Juragua Iron Co., Cuba
Dunkle, Fred W., '03, Deceased
Dunlevy, Forrest S., '08
Price, Utah
DuRell, Chas. T., '95
Consulting Engineer, Imperial Red. Co.,
Consulting Engineer, Homewood Mining Co.,
Consulting Engineer, St. Paul Montana Mining Co., Los Angeles, Calif.
Dwelle, Jesse E., '96, Deceased
Dyer, Chas. E., '10
Asst. Chief Engineer, Ray Cons. Copper Co., Ray, Ariz.
Dyrenforth, Donald, '12
Mining Engineer, Denver, Colo.
Eames, L. B., 05
Mill Supt. Hollinger Gold Mines, Ltd., Timmins, Ont., Canada
East, John H., Jr., '10
Safety Engineer, Mammoth Copper Mining Co., Mammoth, Calif.
Eaton, Albert L., '95
Gen. Supt. Chihuahua M. Co., Chihuahua, Mexico
Eaton, Walter J., '13
Assayer, Plymouth Cons. G. M. Co., Plymouth, Calif.
Eddy, Harold C., '09
Los Angeles, Calif.
Ehle, Mark, Jr., '01
Consulting Engineer, Arcadia, Calif.
Ehrich, Walter L., '02
Secretary and Treasurer, Ehrich Galleries, New York City
Elder, Robert B., '08
Metallurgist, Chiksan Mines, Chosen, Korea
Ellis, T. P., '07
Chief Asst. Engineer, Vulcan Land & Water Co., San Diego, Calif.
Ellis, Wm. W., '02
Denver, Colo.
Ellsworth, Alfred C., '08
Vice-president and Sec., Ellsworth-Klanor Coal Co., Pittsburg, Kans.
Emeis, Walter A., '04
Emeis Mfg. Co., Magneto Experts, Davenport, Iowa
Emens, Ray B., '07
Asst. Engineer, Portland G. M. Co., Victor, Colo.
Emrich, Clarence T, '09
Chief Chemist, Old Dominion Copper M. & Smelting Co., Globe, Ariz.
Emrich, Horace, '03, Deceased

Emrich, Jay L., '12
Chief Chemist, A. S. & R. Co., Durango, Colo.
Engle, Frederick, '11
Denver, Colo.
Enriquez, Edwardo W., '09
Cusi Mexicana M. Co., Cuihuiriachic, Mexico
Erickson, Guy W., '12
Georgetown, Calif.
Espinosa, E. Miguel, '14
Champaign, Ill.
Essig, Benjamin Clark, '15
Professor of Mining, Oklahoma School of Mines, Wilburton, Okla.
Estes, Frank M., Jr., '02
A. S. & R. Co., Spokane, Wash.
Evans, Henry R., '00
City Engineer, Williston, N. Dak.
Evans, Willis W., '08, Deceased
Everest, Herbert A., '08
Supt. Hazelton Coal Co., Coalgate, Okla.
Ewing, Chas. R., '00
U. S. Mineral Surveyor, Del Norte, Colo.
Eye, Clyde M., '95
Benguet Cons. M. Co., Baguio, P. I.
Farnum, Lynn C., 09
Pres. Farnum Bros. Co., General Contractors, Minneapolis, Minn.
Farrar, Russell J., '10
Gold Hunter Mine, Mullan, Idaho
Fay, Chas. H., '13
Engineer, Empire Zinc Co., Hanover, N. Mex.
Fay, Herbert M., '13
Engineer, Tuolumne Copper M. Co., Butte, Mont.
Febles, John C., '97
Chemist, Anaconda Copper M. Co., Butte, Mont.
Field, Edmund M., '12
Kansas City, Mo.
Field, Fred M., '95
Los Angeles, Calif.
Fillius, Lee L., '04
Cyanide Dept., Smuggler Union Co., Telluride, Colo.
Filteau, C. A., '07
Mgr. St. Lawrence Talc Co., Natural Bridge, N. Y.
Finigan, Wm. H., '06
McGowan & Finigan Cord Co., St. Louis, Mo.
Fischer, Oscar A., '14
Denver, Colo.
Fitz Gerald, Ronald P., '10
Assayer and Mining Engineer, Roswell, N. Mex.
Fleming, Wm. L., '03
Stock Broker, New York City
Flinn, Alfred R., '13
Mining Engineer, Empire Zinc Co., Leadville, Colo.
Flint, F. F., '05
Greeley, Colo.
Floyd, John A., '88, Deceased
Foo, Shu, '14
Shanghai, China

Foote, Frederick W., '14
Associate Editor, Engineering & Mining Journal, New York City
Forbes, Henry H., '13
Engineer, Page Wire Fence Co., Monessen, Pa.
Ford, Homer D., '05
Supt. Gilson-Asphaltum Co., Watson, Utah
Foster, George C., '03
Pres. Foster Realty Co., Nelson, B. C., Can.
Franck, Albert C., '04
Sec. and Treas. Citrus Soap Co, San Diego, Calif.
Franck, Robert P., '04
Civil Engineer, San Diego, Calif.
Frank, Harry L., '01, Deceased
Frank, Morton E., '06
Purchasing Agent, Stratford Hotel Co., Chicago, Ill.
Frankel, Jacob M., '13
Sec. to Gen. Supt. of Mines, Arizona Copper Co., Morenci, Ariz.
Frazee, Verne, '12
Engineer, Seoul Mining Co., Holkol, Chosen, Korea
Freeland, Wm. H., '06, Deceased
French, Burr J., '08
Chief Engineer, Cinco Minas Co., Magdalena, Mex.
French, Clare L., '13
Millman, Independent Tungsten Co., Ely, Nev.
French, Sidney W., '08
Assayer, Gold Road Mines Co., Gold Road, Ariz.
Frey, Carl E., '13
Tooele, Utah
Frick, Frederick W., 08
Anaconda Copper M. Co., Anaconda, Mont.
Friedhoff, W. H., '07
Mineral Examiner, U. S. Forest Reserve, San Francisco, Calif.
Fry, Louis D., '03
Supt. Saltillo Smelter, Mazapil Copper Co., Ltd., Mexico
Fullaway, Richard M., '16
Los Angeles, Calif.
Fullerton, Wilfred, '12
Chloride, Ariz.
Funk, Walter A., '03
Mining Engineer, U. S. Mineral Surveyor, Idaho Springs, Colo.
Galligan, John T., '11, Deceased
Gardner, John I., '06, Deceased
Garnett, Thos. H., '11
Supt. San Xavier Mine, Empire Zinc Co., Tucson, Ariz.
Garrison, Murray E., '16
Butte, Mont.
Garza Aldape, J. M., '05
Torreon, Mexico
Gaul, John C., '12
Foreman, Berkeley Mine, Anaconda Copper M. Co., Butte, Mont.
Gauthier, Chas. B., '16
Molybdenum Products Co., Tucson, Ariz.
Geary, E. S., '12
Research Work on Flotation, International Smelting & Ref. Co., Tooele, Utah

Geary, Richard E., '09
Engineer, Gold Hunter M. & S. Co., Mullan, Idaho
Gehrman, Chas. A., '86
Oakland, Calif.
Geib, Carl V., '11
Tomboy, Smuggler, Colo.
Geisel, C. R., '07
Engineer, Denver Union Water Co., Denver, Colo.
Geringer, Geo. T., '10
Supt. Keystone M. Co., Aroroy, Masbate, P. I.
Giddings, Donald S., '00
Chemist, Portland G. M. Co., Victor, Colo.
Gilbert, Arthur K., '06
Assayer and Chemist, Ouray, Colo.
Gilbert, Wm. J., '06
Exchange Manager, Mountain States T. & T. Co., Brighton, Colo.
Glasgow, Charles. M., '10
Supt. Kelley Mine, Empire Zinc Co., Kelley, N. Mex.
Goe, Harold H., '08
Supt. Brick Dept., Anaconda Copper M. Co., Anaconda, Mont.
Golden, J. P., '07
Register Land Office, O'Neill, Nebr.
Goodale, F. A., '10
Engineer and Surveyor, Youbet M. Co., Dutch Flat, Calif.
Goodale, Stephen L., '04
Professor of Metallurgy, Univ. of Pittsburgh, Pittsburgh, Pa.
Gordon, John G., Jr., '06
Chief Engineer, Layne & Bowler Pump Co., Los Angeles, Calif.
Gow, P. A., '07
Mgr. Tuolumne Copper M. Co., Butte, Mont.
Gow, Thomas T., '14
Shanghai, China
Graham, Allan H., '15
Joplin, Mo.
Grant, Lester S., '99
Gen. Mgr. Jumper Californian G. M. Co., Stent, Calif.
Gray, Latimer D., '95
Proprietor, Chandler Ice Co., Chandler, Okla.
Graybeal, Edward V., '14
Anaconda, Mont.
Greensfelder, Nelson S., '12
Inst. in Chemistry, Colorado College, Colorado Springs, Colo.
Greenwood, John Harold, '15
Utah Metal & Tunnel Co., Bingham Canyon, Utah
Gregg, Daniel B., '13
Leadville, Colo.
Greve, E. E., '05
Consulting Engineer, Oil Well Supply Co., Pittsburgh, Pa.
Grider, Richard L., '05
Mining Dept., Univ. of Kansas, Lawrence, Kans.
Grier, Chas. D., '12
Accountant, Cyanide Plant, Alaska-Treadwell G. M. Co., Douglas, Alaska
Griffith, John R., '09
Research Engineer, Worchester, Mass.
Grigsby, Gail G., '14
Platteville, Colo.

Griswold, Geo. G., '96
Supt. Sm. & Lead Refinery, A. S. & R. Co., Maurer, N. J.
Griswold, Geo. G., Jr., '14
Butte, Mont.
Grommon, Philo D., '07
Berthoud, Colo.
Gross, John, '97
Mining Engineer, Denver, Colo.
Gross, LeRoy M., '14
Engineer, Aetna Explosives Co., New York City
Hager, E. T., '12
Los Angeles, Calif.
Hale, Gen. Irving, '05
Gen. Mgr. General Electric Co., Denver, Colo.
Hallett, Alfred F., '09
Manager of Mill, Bonton M. Co., Pitkin, Colo.
Hallett, R. L., '05
Chemist, National Lead Co., Brooklyn, N. Y.
Hallett, Wm. J., '05
Chief Engineer, U. P. Coal Co., Rock Springs, Wyo.
Hamilton, Frank R., '98
Hamilton, Wm. J., '09
Asst. Smelter Supt., Granby Cons. M. S. & P. Co., Ltd., Anyox, B C., Can.
Hammen, Chas. W., '14
Tulsa, Okla.
Hammond, Herbert R., Jr., '13
A. S. & R. Co., Omaha. Nebr.
Hammond, John Hays, (Hon.) '09
Mining Engineer, New York City
Hammond, Wm. L., '09
Treasurer, Sagauche Co., Colo.
Hand. Edwin E., Jr., '14
Assayer, Hind & Johnson, Oatman, Ariz.
Hansen. Chas. L., '09
Orange Grower, Fullerton, Calif.
Harkison, Chas. W., '06
Engineer, Boise Rochester M. Co., Atlanta, Idaho
Harper, Robert R., '14
Goodrich Rubber Co., Kansas City, Mo.
Harrington, Chas. L., 12
Supt. A. R. M. Co., Cedar, Colo.
Harrington, Daniel, '00
U. S. Bureau of Mines, Butter, Mont.
Harrington, Orville, '98
Asst. Sec., etc., C. S. M. Alumni Association, Golden, Colo.
Harris, Arnold W., '12
Chino Copper Co., Hurley, N. Mex.
Harris, Frank B., '13
Tyrone, N. Mex.
Harris, Morrison, '08
Sparrow's Point, Maryland
Harris, Willard F., '01, Deceased
Harrison, Thos. S., '08
Vice-President and Geologist of Enapac Oil & Gas Co., Wiley, Wyo.
Harrod, Wayne Allen, '16
Fort Wayne, Ind.
Hartzell, Lester J., '95
Professor of Chemistry, Montana School of Mines, Butte, Mont.

Harvey, John V., '11
Mine Foreman, Atlas M. & M. Co., Sneffels, Colo.
Haselton, Chas F., '15
Silverton, Colo.
Hawley, R. H., '93
Smelter Supt., Utah Copper Co., Garfield, Utah
Hayden, Wallace H., '14
The Lake Milling, Sm. & Ref. Co., Point Mills, Mich.
Hazard, Wm. J., '97
Professor of Electrical Engineering, Colo. School of Mines, Golden, Colo.
Heatley, F. Eugene, '15
Minas de Matahambre, Prov. of Pinar, del Rio, Cuba
Heaton, Chas. D., '12
Cedar, Colo.
Heinrichs, Walter E., '13
Engineer, Nevada Cons. Copper Co., Ruth, Nev.
Heitz, Geo. H., '06
Testing Dept., Pacific Tel. & Tel. Co., Los Angeles, Calif.
Hensley, James H., Jr., '06
Mining Engineer, Miami Copper Co., Miami, Ariz.
Herres, Otto, Jr., '11
Asst. Engr., Utah Fuel Co., Castle Gate, Utah
Hewitt, A. F., '05
Contracting Engineer, Denver, Colo.
Heister, Arthur J., 12
Empire Zinc Co., Denver, Colo.
Hill, Chas. R., 12
The Dorr Co., Denver, Colo.
Hill, Frank C., '04
Gen. Inspector Utah Fuel Co., Summerset, Colo.
Hills, Leon P., '08
Soulsbyville, Calif.
Hilsdale. Paul, '12
Wellington Mines Co., Breckenridge, Colo.
Hilton, Howard J., '10
Salesman and Member, Hilton & Peck Manufacturers Agts., Phoenix, Ariz.
Hindry, Willis E., '92
Mining Engineer, Pasadena, Calif.
Hinman, Dale Durkee, '15
Empire Zinc Co., Leadville, Colo.
Ho, Chieh, '13
Professor of Mining, Government University, Peking, China
Hodgson, Arthur R., '99
Granby Cons. M. S. & P. Co., Anyox, B. C., Can.
Hollis, D. D., '07, Deceased
Hornbein, Julius, '05
Mineral Inspector, U. S. Land Office, Salt Lake City. Utah
Howat, A. M., '07
Supt. of Mines, Mokelumne Mines Co., Calif.
Howbert, Van Dyne, '16
Kittimac Mines Co., Silverton, Colo.
Hoyt, Geo. F., '96, Deceased
Hu, Shih-hung, '16
Kiukiang, China
Hubbard, John V., '10
Horticulturist, Grass Valley, Calif.
Hudson, Waller C., '13
South American Dev. Co., Guayaquil, Ecuador, So. Am.

Hughes, Earle E., '12
Flotation Engineer, Empire Zinc Co., Canon City, Colo.
Hugo, Herman W., '13
Indianapolis, Ind.
Hull, Cecil B., 09
Engineering Dept. Butte & Superior M. Co., Butte, Mont.
Hunt, Harry D., '09
Chemist, Miami Copper Co., Miami, Ariz.
Hunt, T. R., '05
San Juan Mines, Ltd., Argentina, So. Am.
Huntington, Walter C., '12
Cyanide Chemist, Mogollon Mines Co., Mogollon, N. Mex.
Hutton, Meritt, '14
Chief Engineer, Rembrandt Peale Interests, St. Benedict, Pa.
Hyder, C. A., '05
Hyder & Hyder, Mining Engineers, Nacozari, Mexico
Hyder, Frederick B., '03
Geologist and Mining Engineer, Alaska-Gastineau M. Co., Juneau, Alaska
Ickis, Harry M., '02, Deceased
Ingersoll, Julius C., Jr., '06
Ingersoll, Bell & James, Assayers and Mining Engineers, Ouray, Colo.
Ingles, James A., '08
Mining and Civil Engineer, Milford, Utah
Ireland, Carrol B., '08
San Diego, Calif.
Isom, E. W., '07
Asst. Supt., Cudahy Refining Co., Coffeyville, Kans.
Iwai, Kyosuke, '09
Yusen-i Copper Mine, Takeuchi Mining Co., Ltd., Japan
Izett, Glenn, '03
Denver, Colo.
Jackson, Walter H., '01
Vienna, Ill.
Jacques, Henry L., '08
Supt. of Construction, Water Dept., Los Angeles Public Service, Los Angeles, Calif.
Jarvis, Royal P., '97
Chief Chemist, Cananea Cons. Copper Co., Mexico
Jewel, Gilbert E., '93
Queensland, Australia
Johnson, Byron M., '08
Metallurgical Engineer, Hind & Johnson, Oatman, Ariz.
Johnson, Edward W., '91
University Club, Salt Lake City, Utah
Johnson, Gilbert, Jr., '99, Deceased
Johnson, John B., '14
Carnegie, Pa.
Johnson, Junius W., '01
State Highway Commission, Santa Fe, N. Mex.
Johnson, Lafayette G., '04
Mining Supt., Federal Lead Co., Flat River, Mo.
Johnston, Fred, '98
Asst. Supt., A. V. Smelter, Leadville, Colo.
Jones, Edward B., '00
Mining Engineer, Lehi, Utah
Jones, Ernest F., '10
Engineering Dept., Burro Mountain Copper Co., Tyrone, N. Mex.

Jones, Frank H., '98
Supt. Am. Coal Ref. Co., Denver, Colo.
Jones, Mrs. F. H., '98 (Florence Hazel Caldwell)
Denver, Colo.
Jones, Fred, '00
Mining Engineer, Portland G. M. Co., Victor, Colo.
Jones, Percy, Jr., '08
Ajo, Ariz.
Jones, Vincent, '10
Consulting Hydraulic Engineer, East Las Vegas, N. Mex.
Jones, W. A., Jr., '08
Richmond, Va.
Juchem, Harold H., '10
Cyanide Superintendent, Aguacate Mines, Costa Rica, C. A.
Kaanta, Henry W., '15
Flotation Work, Smuggler Union M. Co., Telluride, Colo.
Keeney, Robert M., '10
Snyder Electric Co., Chicago, Ill.
Kell, Wayne S., '06
Professor of Mining, Georgia School of Technology, Atlanta, Ga.
Kelley, Fred G., '99
Mining Engineer, Salt Lake City, Utah
Kelly, Wm. A., '97
Springfield, Ohio
Kelso, Duane C., '10
Caribou Mines & Mills Co., Caribou, Colo.
Kennedy, Geo. A., '95
Mining Engineer, Western Chemical Mfg. Co., Denver, Colo.
Kenner, Alvin R., '07, Deceased
Kerr, Victor E., '00
Surveyor, Bureau of Lands, Manila, P. I.
Kilbourn, Burwell N., '13
Assayer, A. S. & R. Co., Murray, Utah
Kilbourn, Wm. D., '04
Pueblo, Colo.
Kilgour, Hamilton, '08
Chelmsford Essex, England
Kimball, Geo. K., '92
Owner, Manager, Old Town M. & S. Co.,
Manager, Lamartine Mines Co., Idaho Springs, Colo.
Kimball, Harlow M., '04
Architect, Hollywood, Calif.
Kimball, Joseph S., '92
Central City, Colo.
King, Henry E., '03
Victor Mill, Portland G. M. Co., Victor, Colo.
Kingman, Jerry, '88, Deceased
Kirchman, Robert I., '09
Chino Copper Co., Santa Rita, N. Mex.
Kissock, Alan, '12
General Manager Molybdenum Products Co., Tucson, Ariz.
Klatt, Carl L., '14
Lowell, Ariz.
Kleff, J. M., '06
Mining Engineer, Platt & Kleff, Leadville, Colo.
Knight, Hal G., '08
Manager, Glacier Creek G. M. Co., Porcupine, Alaska

Knight, R. E., '07
Asst. Cashier Alliance National Bank,
City Engineer Alliance, Nebr.,
County Engineer, Box Butte County, Nebr.
Knowles, Benjamin W., '08
Engineer, Daly Red. Co., Ltd., Hedley, B. C., Can.
Koch, Wm. H., '11
Salesman, Hercules Powder Co., Salt Lake City, Utah
Koelker, Karl L., '14
Chemist, International Sm. Co., Tooele, Utah
Koerner, Albert J., '06
Sec. and Treas., Koenitzer Tanning Co., Saginaw, Mich.
Kraemer, Edward L., '98, Deceased
Krohn, Arthur, '14
Leasing, The Golden Tungsten Production Co., Boulder, Colo.
Krueger, Geo. S., '07
Mine Supt., Judge M. & Sm. Co., Park City, Utah
Kruger, Herman A., '09
Cia de Santa Gertrudis, Pachuca, Mexico
Krumm, Samuel Z., '14
Testing Dept. A. C. M. Co., Anaconda, Mont.
Lampe, Oscar A., '98
Mill and Cyanide Supt., Mexico Milling & Trans. Co., Guanajuato, Mexico
Langrall, Chas. A., '08
Mechanical Engineer, Atlantic Can Co., Roland Park, Md.
Lannon, F. P., Jr., '07
U. S. Zinc Co., Sand Springs, Okla.
Lannon, James A., '11
Gen. Supt., Atlas M. & S. Co., Sneffels, Colo.
Larison, E. L., '05
Supt. Acid Dept., Anaconda Copper M. Co., Anaconda, Mont.
Larsh, Walter S., '04
Supt. Underground Mines, Nevada Cons. Copper Co., Ruth, Nev.
Latimer, Bertrand J., '10
El Paso, Texas
Laughlin, Samuel W., '10
Leasing, Ely, Nev.
Laurance, Bert M., '11
Tonopah, Nev.
Lavender, Harrison M., '16
Telluride, Colo.
Leahy, Richard A., '13
Engineering Dept., Anaconda Copper M. Co., Anaconda, Mont.
Lee, Frank W., Jr., '11
Denver, Colo.
Lee, Geo. M., '10
Chemist, Granby Cons M. S. & P. Co., Grand Forks, B. C., Can.
Lee, Hunyet, '16
Batavia, Java
Lee, Ping, '14
World Chinese Students' Federation, Shanghai, China
Lee, Robert P., '05, Deceased
Lee, Wallace, '04
U. S. Geol. Survey, Washington, D. C.
Leeke, Dana W., '10
Seoul M. Co., Holkol, Korea

Lehmer, Frank W., '02
Vera Cruz, Mexico
Lemke, Carl A., '00
Supt. Concentrating Dept., U. S. Sm. Co., Midvale, Utah
Lennox, Luther W., '05
Asst. Supt. Portland G. M. Co., Mill Dept., Victor, Colo.
Lerchen, F. H., '97
Eagle Rock, Calif.
Lesh, Herbert B., '10
Cerro de Pasco Co., Peru, S. A.
Lesher, Carle E., '08
Geologist, U. S. Geol. Survey, Washington, D. C.
Levy, Archibald L., '06
Mag. Great Western Sm. & Ref. Co., Seattle, Wash.
Levy, Milton M., '16
Cedar Talisman M. Co., Milford, Utah
Lewis, Alfred S., '05
Playas Valley, Hachita, N. Mex.
Lewis, Frank E., '01
Engr. for J. A. Hassel, Los Angeles, Calif.
Lewis, Wm. B., '92
Pres. The Oakdale Coal Co., New York City
Lewis, Wm. M., '09
St. Paul, Minn.
Libby, James L., '06
Supt. Lion Coal Co., Lion, Wyo.
Liddell, Chas A., '03
Surveyor, United Comstock Pumping Assoc., Virginia City, Nev.
Liddell, Parker, '03
Rex Red. Co., Midas, Nev.
Light, Victor A., '13
Gold Roads Mines Co., Goldroad, Ariz.
Limbach, Edmund C., '95, Deceased
Link, Karl G., '08
Tom Reed Gold Mine, Oatman, Ariz.
Litchfield, Rufus E., '14
Otsego, Mich.
Lliteras, J. Manual, '16
Alliance, Nebr.
Logue, N. W., '97
A. S. & R. Co., Hayden, Ariz.
Lonergan, P. Jay, Jr., '05
Professor of Mining, Government University, Peking, China
Lorah, Bela J., '88, Deceased
Lovering, Ira G., '01
Copper Queen Mine, Douglas, Ariz.
Lowell, James B., '08
Worchester, Mass.
Lucy, Frank Allen, '01, Deceased
Lucy, Richard W., '98
Denver, Colo.
Luke, Russell P., '14
Supt. Hardshell M. Co., Patagonia, Ariz.
MacGregor, Geo. H., '97
Terrebonne, Ore.
MacKay, Donald R., '12
Mine Engineer, Detroit Copper M. Co., Morenci, Ariz.
MacNeill, Neil M., '14
Assay Laboratory, Butte & Superior Copper Co., Butte, Mont.

Maganeau, Wm., '98, Deceased
Malmstrom, C. G., '00
Asst. Assayer, U. S. Mint, Denver, Colo.
Marrs, Geo. O., '01
Attorney at Law, Denver, Colo.
Marshall, Emory M., '11
Efficiency Engineer, Old Dominion Copper M. & S. Co., Globe, Ariz.
Martin, J. A., '07
Asst. Engr. Chino Copper Co., Santa Rita, N. Mex.
Martinez, Fidel, '13
Asst. Metallurgical Engineer, Chino Copper Co., Hurley, N. Mex.
Matheson, Kenneth H., '11
Supt. San Marcos Mine, Honduras, C. A.
Mathews, Harvey, '13
Bonanza Mine, N. C. & L. Co., Nicarauga, C. A.
Matteson, Wallace G., '11
Instructor in Geology, Lehigh University, So. Bethlehem, Pa.
Maxwell, Fred A. G., '95
Cons. Metallurgist, Gen. Mining and Finance Corp., Johannesburg, So. Africa
May, Andrew J., Jr., '12
Tazewell, Va.
May, Arthur L., '11
Manager, Crichton-Curl Enamel Co., Elwood City, Pa.
May, John G., '01
Mining Engineer, Denver, Colo.
May, Ross R., '12
Draftsman and Engineer, Butte & Superior M. Co., Butte, Mont.
Mayer, Walter J., '11
Manager, Utah Exploration & M. Co., Salt Lake City, Utah
Maynard, Rea E., '96
Manager, Gen. Pipe Line Co. of California
Chief Engineer Gen. Petroleum Co., Los Angeles, Calif.
McCallum, Jean M., '10
Supt. of Mines and Mills, Caribou Mines & Mill Co., Caribou, Colo.
McCart, Robert, Jr., '05
Gen. Mgr. Inde G. M. Co., El Paso, Texas
McCormick, David F., '10
Supt. and Chief Engr., Minas de Matahambre, Cuba
McDaniel, Alexander K., '01
Consulting Engr., American Zinc, Lead & Sm. Co.,
Consulting Engr., Wisconsin Zinc Co.,
Consulting Engr., Dutch Sweeney M. Co.,
Consulting Engr., Oceanic Quick Silver Co.,
Consulting Engr., Black Iron M. Co., Denver, Colo.
McDermutt, Grace C. U., '03 (Mrs. Barry Mulligan)
Kensington, Md.
McDonald, Jesse F.,
Manager Downtown Mines Co., Leadville, Colo.
McElvenny, Robert F., '03
Gen. Supt., Tacoma Plant, A. S. & R. Co., Tacoma, Wash.
McGregor, M. S., '13
McGregor & Sons, County Distributors, Firestone Tires, Auto Supplies, etc., Santa Barbara, Calif.
McGuire, Philip Jenner, '15
Victor, Colo.

McHugh, Philip M., '11
Sales Manager, Dorr Co., Denver, Colo.
McKay, Glover S., '10
Mex. Candelaria Co., San Francisco, Calif.
McKnight, Hugh S., '15
Mine Sampler, Seoul Mining Co., Korea
McLeod, J. N., '97
In charge of Assay Dept., Smith Emery & Co., San Francisco, Calif.
McMahan, Chas. H., '92
Mining Engineer, Denver, Colo.
McNicholas, Frederick S., '14
Butte, Mont.
Medell, Wm. S., '95
Stanley Chemical Co., New York City
Merryman, Herbert E., '95
Deputy County Surveyor, Warrensburg, Mo.
Mertes, Albert T., '12
Chemist, Chemical Products Co., Denver, Colo.
Merwin, E. W., '03
Civil Engineer, Los Angeles Harbor, San Pedro, Calif.
Middlekamp, L. L., '05
Supt. Ellamar M. Co., Ellamar, Alaska.
Middleton, Wm. B., '83
Nederlands Trading Soc. Bank, Penang, Federated Malay States
Millard, Frank W., '01
Mining Engineer, Ely, Nev.
Miller, DeMont G., '09
Engineer, Layne Bowler Corp., Bakersfield, Calif.
Miller, Roy H., '16
Anaconda Copper M. Co., Anaconda, Mont.
Milliken, John Tait, '96
Consulting Mining and Metallurgical Engineer, Colorado Springs, Colo.
Milliken, Wm. B., '93
Mining and Metallurgical Engineer, Denver, Colo.
Minister, Howard L., '16
Canon City, Colo.
Mitchell, Geo. B., '96
Contractor and Engineer, Montreal, Canada
Montrose, James F., '02
Montrose & Son, Denver, Colo.
Moore, C. A., '12
Empire Zinc Co., Kelly, N. Mex.
Moore, C. F., '07, Deceased
Moore, Geo. P., '07
Hartford, Conn.
Moses, Percival S., '14
Forminiere Mission, Belgian Congo, Africa
Moss, Cleveland O., '02
France Investment Co., Los Angeles, Calif.
Moynahan, Ambrose E., '00
State Inspector of Mines, Alma, Colo.
Muir, David R., '99
Manager, Gold Road Mines Co.
Manager, Needles M. & Sm. Co., Goldroad, Ariz.
Muir, Douglas, '05
Supt. Guanajuato Mines & Red. Co., San Antonio, Texas

Murch, Clarence H., '08, Deceased
Murchison, E. H., '12
Eaton, Colo.
Myers, John F., '13
Flotation Engineer, Empire Zinc Co., Canon City, Colo.
Nagel, Frank J., '03
Mining Engineer, Cia Minera de Penoles, S. A., El Paso, Tex.
Nagel, Henry P., Jr., '04
Supt. Vindicator Cons. G. M. Co., Independence, Colo.
Nance, Wm. H., '96
Assayer, Ohio & Colorado Smelter, Salida, Colo.
Neiswender, Chester B., '13
Los Angeles, Calif.
Nelson, H. E., '97
Engineer, Yuma Cons. M. Co., Los Angeles, Calif.
Neugebauer, Karl E., '06
Chemist, C. F. & I. Co., Pueblo, Colo.
Neville, J. B., Jr., '05
Cripple Creek, Colo.
Newnam, Wm. E., '96
Supt. Collinsville Plant, St. Louis Sm. & Ref. Co., Collinsville, Ill.
Nicholson, Geo. W., '00
Los Angeles, Calif.
Nieman, Earl F., '13
Resident Manager, Harmony Mines Co., Salmon City, Idaho
Nolan, Phillip E., '13
Civil Engineer, U. S. R. Service, Meadow Creek, Wash.
Norman, J. E., '98
Broomfield, Colo.
Norton, A. C., '07
Chief Engineer, R. Hardesty Mfg. Co., Denver, Colo.
Nyberg, H. E., '06
Compania Minera "Las Dos Estrellas," El Oro, Mexico.
Nye, Robert, '97
Consulting Engr., G. S. Johnson Co., Reno, Nev.
O'Byrne, Joseph F., '05
Mining Engineer, Jarbidge, Nev.
Olsen, Chas. O., '11
Spokane, Wash.
Olson, Van Cleave Arthur, '15
Sheep Mountain Mine, Crystal, Colo.
Oram, Chas F., '13
Pingrey Mines & Ore Red. Co., Leadville, Colo.
Osborne, Arthur H., '93, Deceased
Page, Lawrence C., '08
H. L. Page & Co., Inc., Norfolk, Va.
Page, Walter Chatfield, '15
Research Dept., International Sm. Co., Tooele, Utah
Palsgrove, Harry G., 03
Asst. Manager, The Aguacate Mines, Costa Rica, C. A.
Paredes, Evaristo, '05
Gen. Mgr. La Prieta M. Co., Sinaloa, Mexico.
Parker, James H., '95
El Paso, Texas
Parker, Nathan H., '16
Trinidad, Colo.
Parks, Geo. A., '06
U. S. Land Office, Mineral Examiner, Juneau, Alaska

Parrish, Karl C., '01
Cartegena, Colombia, S. A.
Parsons, F. H., '07
Olalla, B. C., Can.
Parson, Horace F., '03
Orlanda, Fla.
Patrick, Wm. B., '09
Littleton, Colo.
Patterson, S. B., Jr., '06
Asst. Gen. Mgr. The Spanish American Iron Co., Felton, Cuba
Paul, Russell B., '02
Mining Engineer, Empire Zinc Co., Denver, Colo.
Paul, Wm. H., '96
Consulting Mining Engineer, Alotopeque Mines, Guatamala, C. A.
Pearce, James W., '14
Asst. Supt., Tecopa Cons. Mines Co., Tecopa, Calif.
Pendery, John M., '00
Mining Engineer, Leadville, Colo.
Peregrine, Wm. D., '13
Tomboy Mine, Smuggler, Colo.
Perkins, Alfred E., '10
Western Mgr., Colonial Steel Co., Denver, Colo.
Pfeiffer, G. N., '05
St. Joseph Lead Co., Bonne Terre, Mo.
Phelps, Harlow D., '10
Denver, Colo.
Phelps, W. B., '07
Seattle, Wash.
Pilger, Newton W., '06
Gen. Merchant, Anchorage, Alaska
Pittman, Frank L., '14
Butte, Mont.
Place, J. Sterling, '13
Braden Copper Co., Rancagua, Chili, S. A.
Platt, Edwin H., '00
Mining Engineer, Denver, Colo.
Post, Geo. M., '94
Engineering & Contracting, Denver, Colo.
Powell, Geo. F., '97
U. S. Manganese Corp., Elkton, Va.
Powers, Oliver, '02
Gen. Mgr. San Toy M. Co., Chihuahua, Mexico.
Pray, Milton A., '08
Wadsworth, Nev.
Pray, Winfred A., '01
Fernley, Nev.
Pressler, L. P., '05
Supt. Ozark S. & M. Co., Magdalena, N. Mex.
Price, Harold C., '13
In charge of Oxide Plant, Bartelsville Zinc Co., Okla.
Price, Lyttleton, '00
Gen. Engineering & California Oil, Los Angeles, Calif.
Prier, Truman D., '04
Engineer, Conrey Placer Mining Co., Ruby, Mont.
Prior, Chas. E., '13
Chemist & Assayer, Hedley G. M. Co., Hedley, B. C., Can.

Prout, John, '00
Golden, Colo.
Pullen, Lester L., '10
Syndicate M. Co., Aroroy, Masbate, P. I.
Purdy, Irvine A., '10
Kennewick, Wash.
Putnam, Geo. B., '05, Deceased
Quayle, Thos. W., '07
Night Mine Foreman, Burro Mountain Copper Co., Tyrone, N. Mex.
Rabb, E. M., '05
Manager, Tom Reed G. M. Co., Oatman, Ariz.
Ralph, Walter H., '16
U. S. Mines, Bingham Canyon, Utah
Rambo, W. C. J., '09
Norristown, Pa.
Ramlow, W. G., '12
Engineer, Empire Zinc Co., Cleveland Mine, Silver City, N. Mex.
Ramsey, E. R., '12
Sales Engineer, The Dorr Co., Denver, Colo.
Ransom, Rastus S., Jr., '13
New York City
Rath, C. M., '05
Surveyor of Mineral Deposits, U. S. General Land Office, Cheyenne, Wyo.
Reinhard, Frank J., '05
Golden, Colo.
Reno, Chas. A., '08
Ripley, Nev.
Reno, Horace T., '02
Denver, Colo.
Rhodes, Wm. B., '03
Olimpo del Valle, Colombia, S. A.
Rich, Joseph U. G., '08
Nashville, Tenn.
Richards, E. R., '05
Manager, Childers Leasing Co., Midvale, Utah
Richards, John V., '02
Mining Engineer, Spokane, Wash.
Richardson, Allan S., '12
Research Dept., Anaconda Copper M. Co., Butte, Mont.
Ripley, Geo. C., '06
Foreman Flotation Plant, B. & M. Red. Dept., Anaconda Copper M. Co., Great Falls, Mont.
Rising, Arthur F., '99, Deceased
Ristedt, Ernest J., '09
Chief Chemist, Old Dominion Copper M. & S. Co., Globe, Ariz.
Roberts, Henry M., '12
Sec. J. Fred Roberts Construction Co., Denver, Colo.
Roberts, Keith, '15
Dome Mine, South Porcupine, Ont., Can.
Robey, Lloyd, '00
Las Cruces, N. Mex.
Robinson, Geo. P., '04
Asst. Supt. of Smelter, A. S. & R. Co., Sasco, Ariz.
Rockwood, Carl A., '12
Anaconda, Mont.

Rodriquez, J. C., '98
Coahuila, Mexico
Rogers, Chas. Arthur, '15
Salida, Colo.
Roller, Arthur H., '97
Pres. & Gen. Mgr. Alice Mines Corp., Denver, Colo.
Root, Chas D., '08
Denver, Colo.
Rosette, Breese, '15
Engineer, Montezuma Copper Co., Sonora, Mexico
Ross, Geo. M., '07, Deceased
Rowe, Chas. E., '02
Assoc. Prof. of Drawing, Univ. of Texas, Austin, Tex.
Rowe, Edward E., '95
Black Hawk, Colo.
Royer, Frank W., '99
Consulting & Mining Engr., Los Angeles, Calif.
Rudd, Arthur H., '00
County Surveyor, Joseph, Ore.
Rusman, Benjamin A., '13
Chemist, International Sm. Co., Tooele, Utah
Russell, Donald O., '09
Kuala Lumpur, Selangor, Fed. Malay States
Ryan, W. E., '05
Vindicator G. M. Co., Denver, Colo.
Sackett, Blair L., '09
Chief Testing Engr., International Sm. Co., Tooele, Utah.
St. Dizier, Julius L., '94
Metallurgical Accountant, International Sm. Co., Miami, Ariz.
Sale, Andrew J., '01
Gen. Mining Engineer, Cons. Copper Mines Co., Kimberly, Nev.
Sandusky, Samuel C., '08
Engineer, Gemini M. Co., Eureka, Utah
Saxton, Frank B., '12
Asst. Engr., Vindicator Cons. G. M. Co., Victor, Colo.
Shafer, Louis, '09.
Mining Engineer, Silverton, Colo.
Scheble, Max C., '01
Supt. Bokoshe Smokeless Coal Co., Bokoshe, Okla.
Schellenberg, Gustave W., '12
Asst. Chief Engineer, Northern Electric Ry., Sacramento, Calif.
Schlereth, C. Q., '06
Supt. of Mines, Ojuela, Dgo., Mexico
Schneider, August W., '11
Mine Foreman, Hazelton Coal Co., Coalgate, Okla.
Schneider, Geo. W., '94
Gen. Mgr., Bolivia Gold Exploration Co., Sorata, Bolivia, S. A.
Schumann, Enrique A., '97
Shaver, F. J., '07
San Jacinto, Calif.
Shaw, Ralph H., '11
Yuba Leasing & Dev. Co., Pinoche, Nev.
Sherman, Scott H., '04
Supt. Christmas Mine, A. S. & R. Co., Christmas, Ariz.
Shetler, Waverly, '95, Deceased
Showman, Harry M., '10
Asst. Prof. Civil Engineering, C. S. M., Golden, Colo.

Sill, Rush H., '06
Consulting Mining Engineer, Sill & Sill, Los Angeles, Calif.
Silver, Leopold, '10, Deceased
Simon, Wm. Wayne, '15
Assayer & Chemist, Magma Copper Co., Superior, Ariz.
Simpson, Wm. P., '01
Denver, Colo.
Skavlem, Henry G., '10
Supt. Canadian M. & F. Co., Ltd., Timmins, Ont., Can.
Skinner, Lewis B., '95
Treas. & Gen. Mgr. Western Chemical Co., Denver, Colo.
Slater, Amos, '00
Mining Engineer, Seattle, Wash.
Sloan, W. A., '03
Glendale, Calif.
Small, Harvey B., '01
Colombia, S. A.
Smith, Albert W., '14
Rolling Mill Foreman, Youngstown Sheet and Tube Co., Youngstown, Ohio
Smith, C. Dupree, '91
San Diego, Calif.
Smith, Claude H., '00, Deceased
Smith, E. M., '05
Contracting Engineer, Smith Construction Co., Ohanogan, Wash.
Smith, Frank A., '16
Engineer, Seminole Mine, Rawlins, Wyo.
Smith, Harry C., '98, Deceased
Smith, Howard C., '13
Ray Cons. Copper Co., Ray, Ariz.
Smith, Ralph W., '14
Potossi Mine, Arden, Nev.
Smith, Roy F., '11
Supt. Cleveland Mine, Empire Zinc Co., Silver City, N. Mex.
Smith, Thos. G., '99
McGill, Nev.
Snedaker, Eugene G., '14
Experimental Flotation, Goldfield Cons. Mining Co., Goldfield, Nev.
Snow, Robert E., '11
Mine Engineer, Tomboy G. Mines Co., Ltd., Smuggler, Colo.
Solomon, Irwin R., '13
City Salesman, Great Western Sm. & Ref. Co., Chicago, Ill.
Soupcoff, Samuel M., '10
Mining Engineer, Seward, Alaska
Spangler, Howard, '05
Supt. Manganese Property, Camp, Utah
Spencer, Walter I., '04
Gresham, Ore.
Spring, Archer T., '12
Sunnyside Mine, Eureka, Colo.
Stannard, Burt C., '95
Metallurgist, Selby Sm. & Lead Co., San Francisco, Calif.
Starbird, Edwin P., '01
San Pedro, Calif.
Starbird, H. B., '97
Chief Engineer and Supt. El Sobrante Land Co., Arlington, Calif.

Steele, James H., '00
Instructor Manual Training H. S., Denver, Colo.
Stein, Edmund, '13
Mining Draftsman, U. S. Bureau of Mines, Pittsburgh, Pa.
Steinhauer, Fred C., '99
Park Supt., Denver, Colo.
Stephens, Chas. N., '98
Chemical Engr. Work, Tacoma Smelter, Tacoma, Wash.
Stephens, Frank M., '13
Supt. Potossi Mine, Empire Zinc Co., Arden, Nev.
Stephens, Wallace A., '93
Mining Engineer, Denver, Colo.
Stephenson, Tiffanay E., '06
Fort Morgan, Colo.
Stewart, Hugh A., '12
Supt. Chungtanil & Yang Chun Mines, Chiksan M. Co., Chosen, Korea.
Stewart, Lincoln Adair, '15
Syndicate M. Co., Aroroy, Masbate, P. I.
Stockton, Robert S., '95
Supt. of Operation and Maintainence, C. I. Ry., Alberta, Can.
Stoeckley, E. F., '05
San Diego, Calif.
Storm, Lynn W., '02
Alaska-Gastineau M. Co., Juneau, Alaska
Stotesbury, H. W., '07
Chief Engineer, Tonopah M. Co., Tonopah, Nev.
Street, Gerald B., '01
Mining Engineer, E. I. du Pont de Nemours Co., Wilmington, Del.
Strohl, Geo. F., '10, Deceased
Stronck, Hubert N., '13
Benedict, Boyle & Stronck, Inc.,Industrial Engrs., Chicago, Ill.
Strong, Earle A., '14
Engineer, The Dorr Co., Denver, Colo.
Strout, Fred McL., '96
Assayer, Cripple Creek, Colo.
Stuart, Malcolm M., '08
Butte, Mont.
Suhr, Otto B., '95
Los Angeles, Calif.
Swainson, Otis W., '10
U. S. Coast and Geod. Survey, Manila, P. I.
Swanson, C. Arthur, '13
Am. Zinc Co., Denver, Colo.
Taggart, Geo. K., '03
Sonora, Mexico
Taggart, Oliver R., '09
Chemist, St. Louis Sm. & Ref. Co., Collinsville, Ill.
Taylor, Harry P., '00
Los Angeles, Calif.
Taylor, Lemuel K., '14
Hongkong, China
Teets, John N., '15
Assaying and Mining, Red Cliff, Colo.
Terrill, A. C., '05
Prof. of Mining and Ore Dressing, Univ. of Kansas, Lawrence, Kans.
Tescher, Samuel, '04
Am. Fuel Co., Denver, Colo.

Thomas, John S., '04, Deceased
Thomas, Lester C., '12
Sales Dept., Ford Motor Co., Denver, Colo.
Thompson, James S., '99
Gen. Supt., Utah Fuel Co., Castle Gate, Utah
Thomson, A. T., '05
Asst. Supt. and Metallurgist, Ohio & Colo. Smelter, Salida, Colo.
Thomson, Francis A., '04
Head of Dept. of Mining and Metallurgy, State College of Washington, Pullman, Wash.
Thum, Ernest E., '06
Asst. Prof. of Metallurgy, Univ. of Cincinnati, Cincinnati, Ohio
Thurston, Ralph V., '11
Experimental Work, Miami Copper Co., Miami, Ariz.
Titsworth, Frederick S., '95
Attorney at Law, Pershing, Titsworth & Fry., Denver, Colo.
Toenges, Albert L., '12
Mine Foreman, Doe Run Lead Co., Flat River, Mo.
Townsend, Arthur R., '99
New York City
Traver, W. M., Jr., '16
Engineer Seminole Mine, Rawlins, Wyo.
Trott, Maynard J., '08
Asst. Supt. Golden Cycle Mill, Colorado Springs, Colo.
Trott, Ronald S., '06
Inventor and Mechanical Engineer, Trott Automobile Co., Detroit Mich.
Trueheart, Lawrence G., '13
San Antonio, Texas
Trumbull, Loyal W., '04
State Geologist, Cheyenne, Wyo.
Tsai, Hsiang, '15
Olivier & Co., Hankow, China
Tsui, Y. L., '14
Washington, D. C.
Turner, John H., '14
Bolivia Exploration Co., Bolivia, S. A.
Tyler, Sydney B., '99
Denver, Colo.
Utley, Howard H., '00
Manager, River Sm. & Ref. Co., Florence, Colo.
Vacek, Vincent F., '10
Prop. and Mgr., Vacek Dept. Store, South Omaha, Nebr.
Valentine, Malvern R., '98
Portland G. M. Co., Victor, Colo.
van Diest, Edmond C., '86
Consulting Engineer, Colorado Springs, Colo.
Van Dolah, P. B., '15
Foreman, Custer Slide Mining & Dev. Co., Bonanza, Idaho
Van Dorp, Glen H., '15
Mine Sampler and Asst. Surveyor, Liberty Bell Mine, Telluride, Colo.
Van Wagenen, Hugh R., '06
Gen. Supt., Cons. Nevada Utah Corp., Pioche, Nev.
Vaughn, Robert M., '04, Deceased
Voelzel, Gustave W., '11
Asst. Townsite Engr., Burro Mountain Copper Co., Tyrone, N. Mex.

Vorck, Chas. R., '16
Assayer, Pittsburgh-Dolores M. Co., Rockland, Nev.
Wackenhut, Geo. J., '04
Victor, Colo.
Walker, A. D., '12
Asst. Supt., Vindicator Cons. G. M. Co., Independence, Colo.
Wallace, Howard J., '04
Great Falls, Mont.
Wallace, Louis R., '95
Supt. International Sm. Co., Miami, Ariz.
Walter, Adolph S., '15
Chemist, Durango Plant, A. S. & R. Co., Durango, Colo.
Waltman, Will D., '99
Gen. Mgr. Franco-Wyoming Oil Co., Casper, Wyo.
Wang, Shoa-Ying, '13
Technical Expert, First Mining Dist., Government Univ., Peking, China
Ward, Merwin H., '13
Manager, Stanley Motor Car Co., St. Louis, Mo.
Ward, Wm. F., '03
Wesselhoept & Wisner, Barrinquilla, Colombia, S. A.
Warfel, C. G., '07
Denver, Colo.
Warnecke, Carl M., '97
Asst. Electrical Engr., P. E. R. R. Co., Sherman, Calif.
Warren, Seymour P., '13
Joplin, Mo.
Washburn, Howard G., '04
Supt. Federal Lead Co., Flat River, Mo.
Wasley, Wm. A., '09
Mill Supt., El Tigre M. Co., Sonora, Mexico
Watrous, Mark U., '14
Surveyor, Ozark S. & M. Co., Magdalena, N. Mex.
Watson, Guy P., '10
McGill, Nev.
Watson, Hugh C., '01
Gen. Supt. Wisconsin Zinc Co., Platteville, Wis.
Watson, Samuel E., '13
Anaconda, Mont.
Wattles, Wm. C., '03
City Engineer, Tropico, Calif.
Watts, Alfred C., '02
Chief Engineer, Utah Fuel Co., Salt Lake City, Utah
Weed, Floyd, '97
Manager Bailey Cobalt Mines, Ltd., Giroux Lake, Ont., Can.
Weil, Jacob, '04
Quincy, Fla.
Weinig, Arthur J., '08
Mill Supt., Liberty Bell G. M. Co., Telluride, Colo.
Weir, John A., '09
Chief of Party, Irrigable Land Survey, U. S. R. S., Delta, Colo.
Weiss, Andrew, '99
Project Manager, U. S. R. S., Mitchell, Nebr.
Weisz, Joseph J., '09
Chicago, Ill.
Wells, Ben T., '04
Manager, Minas de Alotepeque, Guatamala, C. A.
Wells, Frank B., '03
Pacific Creamery Co., Tempe, Ariz.
Wertheim, Solomonson F. M. G. A., '89, Deceased

West, John R., '10
City Engineer's Office, San Diego, Calif.
Wheeler, Chas. E., '94
Lampajos, Mexico
Wheeler, Robert M., '08
Mill Supt., Colorado-Nevada M. & M. Co., Nelson, Nev.
Whetsel, Raymond V., '16
Burma Mines, Ltd., Burma, India
Whitaker, Chas. N., Jr., '14
Good Springs, Nev.
Whitaker, Orvil R., '98
Mining Engineer, Denver, Colo.
White, J. L., '07
Supt. De Soto Mine, Cons. Arizona Sm. Co., Ocotillo, Ariz.
White, Leonard L., '15
Shift Boss., N. Y., Honduras & Rosario Co., Honduras, C. A.
Whitehead, Paul, '12
Ray Cons. M. Co., Ray, Ariz.
Whitehouse, Howard D., '08
E. H. Rollins & Sons, Chicago, Ill.
Whitehurst, J. W., '10
Supt. Estaca M. Co., San Francisco, Calif.
Wiebelt, Frank J., '16
Butte, Mont.
Wigton, Geo. H., '13
Foreman, Electrolytic Plant, Anaconda Copper M. Co., Anaconda, Mont.
Wilcoxson, Edward D., '12
Hurley, N. Mex.
Wiley, Walter H., '83
Mining Engineer, Glendora, Calif.
Wilfley, Elmer R., '14
Silverton, Colo.
Wilfley, Geo., '13
Gen. Supt. Mears & Wilfley, Silverton, Colo.
Wilkinson, Merle W., '13
A. S. & R. Co., Omaha, Nebr.
Williams, Fred T., '01
Pres. & Gen. Mgr., Federal Leasing Co., Park City, Utah
Williams, Irving B., '11
Anaconda, Mont.
Williams, John C., '13
Asst. Supt. National Radium Inst., Denver, Colo.
Williams, Wakely, '99
Supt. Smelting Plants, Granby Cons. M. S. & P. Co., Grand Forks, B. C., Can.
Wilson, Dudley M., '09
Right of Way Engineer, Texas Power & Light Co., Dallas, Texas
Wilson, Harry R., '16
Burma Mines, Ltd., Burma, India
Wolf, A. G., '07
Mining Engineer, Denver, Colo.
Wolf, Harry J.. '03
Prof. of Mining, C. S. M., Golden, Colo.
Mining Engineer, Denver, Colo.
Wong, Wm. A., '13
Honolulu, Hawaii

Wood, Ernest B., '09
Mech. Engr. & Asst. to Supt., Colorado-Portland Cement Co., Portland, Colo.
Woods, Thomas H., '97
Supt. of Mill, Camp Bird, Ltd., Ouray, Colo.
Woolf, Joe H., Jr., '14
Seoul Mining Co., Chosen, Korea
Wraith, Chas. R., '11
Anaconda, Mont.
Wright, Thos. W., '13
Mine Sampler & First Aid Instr., Calumet & Ariz. M. Co., Lowell, Ariz.
Wuensch, Chas. Erb, '14
Butters Salvador Mines, Salvador, C. A.
Yang, W. T., '14
Shanghai, China
Youker, C. Norman, '12, Deceased
Young, Frank B., '95, Deceased
Young, Peter A., '13
Sugar Loaf, Colo.
Zulch, Herman C., '08
Mining Engineer, Foster & Zulch, Oatman, Ariz.
Zulch, Wm. G., '14
Mine Engineer, Vindicator Cons. G. M. Co., Victor, Colo.
Zwetow, Arthur N., '11
Denver, Colo.

GEOGRAPHICAL DISTRIBUTION OF GRADUATES

UNITED STATES AND POSSESSIONS

Colorado	201	Philippine Islands	6
California	71	Kansas	5
Arizona	53	Virginia	5
Montana	49	Massachusetts	3
Utah	42	Ohio	3
Nevada	36	Alabama	2
New Mexico	25	Delaware	2
Missouri	14	Florida	2
Washington	13	Indiana	2
Illinois	12	Iowa	2
New York	12	Minnesota	2
Texas	12	New Jersey	2
Territory of Alaska	10	Territory of Hawaii	2
Pennsylvania	10	Wisconsin	2
Oklahoma	9	Arkansas	1
Michigan	8	Connecticut	1
Nebraska	8	Georgia	1
Wyoming	8	New Hampshire	1
Maryland	7	North Dakota	1
Idaho	6	South Dakota	1
Oregon	6	Tennessee	1

Total United States 659

FOREIGN COUNTRIES

Mexico	24	Federated Malay States	2
Canada	16	Guatemala	2
China	14	Honduras	2
Korea	9	India	2
Columbia	5	Peru	2
Africa	4	Argentina	1
Cuba	4	England	1
Australia	2	Japan	1
Bolivia	2	Java	1
Chile	2	Nicaragua	1
Costa Rica	2	Porto Rico	1
Ecuador	2	Salvador	1

Total Foreign 103

SUMMARY

United States	659
Foreign Countries	103
Total Living Graduates	762
Deceased	57
Grand Total	819

Of the total number of living graduates, 84 per cent are located within the United States. Of the graduates in the United States, 30 per cent are located in Colorado. Of the graduates engaged in foreign countries, 51 per cent are in Spanish-American countries.

INDEX

Page
Accidents 110
Accounting, Mine 56
Administration Building 21
Admission Requirements 34
Admission to Advanced Standing.... 38
Advanced Algebra 97
Advanced Calculus 101
Advanced Engineering Drawing 82
Advanced Quantitative Analysis.... 93
Advanced Standing 38
Air Compressors and Pumps.... 85
Algebra, Advanced 97
Algebra, College 97, 98
Alloys, Research in 67
Alternating Current Machinery....79, 80
Alternating Currents 95
Alumni 130
Alumni Association 122
Analytic Geometry 99
Analytical Mechanics 75
Applied Electricity 81
Applied Mechanics 75
Assay Building 21
Assaying 63
Assay Laboratory 28
Astronomy 103
Athletics and Physical Training....121
Board and Lodging....116
Board of Trustees.... 10
Books, Text 116
Buildings 21
Bureau of Mines, Laboratories of the United States.....32, 121
Business Correspondence 105
Calculus 100, 101
Calculus, Advanced 101
Calendar 9
Campus, Illustration 16
Carpenter Shop 23
Chemical Laboratories 29
Chemistry 88
Chemistry, General 88
Chemistry, Hall of.... 21
Chemistry, Industrial 92
Civil Engineering 74
Class of 1917 123
Class of 1918 124
Class of 1919 125
Class of 1920 126
Class of Prospectors....129
Coal Mining 58, 59
Collection of Commercial Ores.... 26
College Algebra 97, 98

Page
Commencement 9
Committees of the Faculty 13
Composition, English 105
Compressors, Air 85
Conditions 117
Construction, Engineering 77
Contents 7
Copper, Metallurgy of 65
Corporations, Mining 58
Correspondence, Business 105
Course for Prospectors 113
Courses of Instruction 42
Crystallography 68
Degrees 39
Departments of Instruction 41
  Chemistry 88
  Civil Engineering 74
  Electrical Engineering 79
  English 105
  Geology and Mineralogy 68
  Mathematics 97
  Mechanical Engineering 82
  Metallurgy 63
  Mining 53
  Modern Languages 107
  Physics 94
  Safety Engineering 109
Deposits 52
Descriptive Geometry 82
Design of Metallurgical Plants 67
Design of Mine Plants 87
Design of Mine Power Plants 86
Differential Equations 102
Diplomas 39
Direct Current Machinery 79
Distribution of Graduates 159
Drawing, Engineering 82
Drawing Rooms 33
Economic Geology 71
Economics of Mining 60
Electrical Engineering 79
Electrical Laboratory 30
Electrical Measurements 96
Electrical Plant Trips 112
Electricity Applied to Mining 80
Electrometallurgy 66
Electron Theory and Radioactivity 95
Elementary Machine Design 83
Engineering Construction 77
Engineering Drawing 82
Engineering Mathematics 101
Engines, Heat 84
Engines, Internal Combustion 86
English 105
English Composition 105
Enrollment of Students 123
Entrance Examinations 34
Entrance Requirements 34

Page
Equations, Differential 102
Equations, Theory of 102
Equipment 24
Equipment of Mines 61
Examination of Mines 59, 62
Examinations for Entrance 34
Exchanges 27
Expenses 116
Board 116
Books 116
Deposits 52
Fees 51
Lodging 116
Other Expenses 116
Students' Supplies 116
Tuition 113
Experimental Plant 4, 22
Explosions 109
Extension Work 121
Faculty 11
Failures 117
Fees 51
Field Geology 72
Financial Support 20
Fires, Mine 109
First Aid to the Injured 110
Five-Year Course 46
French 108
Freshman Class 126
Fuels, Research in 67
Funds, Loan 121
Gas, Geology of 72
General Chemistry 88
General Geology 68
General Information 113
General Metallurgy 63
General Physics 95
Geographical Distribution of Alumni 159
Geographical Distribution of Students 128
Geological Laboratory 26
Geology and Mineralogy 68
Geology, Economic 71
Geology, Field 72
Geology, Historical 70
Geology of Oil and Gas 72
Geology, Structural 72
Geometry, Analytic 99
Geometry, Descriptive 82
Geometry, Solid 97
German 108
Gold, Metallurgy of 65
Grading, Method of 117
Graduates 130
Graduation 39
Guggenheim Hall 21
Gymnasium 21
Heat 94
Heat Engine Design 84

Page
Heat Engines 84
Heating 22
Historical Geology 70
History 19
Holidays 9
Hydraulic Laboratories 29
Hydraulics 76
Industrial Chemistry 92
Information, General 113
Inspection Trips 112
Instruction, Courses of 42
Integral Club 120
Internal Combustion Engines 86
Interpretation of Maps 71
Investments, Mathematics of 102
Iron, Metallurgy of 64
Junior Class 124
Kinematics of Machinery 83, 84
Laboratories and Equipment 24
Laboratories of the U. S. Bureau of Mines 32
Laboratory, Testing 76
Languages, Modern 107
Lead, Metallurgy of 64
Least Squares and Practical Astronomy 103
Lectures, Special 14
Library 118
Lighting 22
Lithology 70
Loan Funds 121
Location and Description 17
Lodging 116
Machine Design 83
Machine Shop 23
Management of Mines 60
Maps, Interpretation of 71
Mathematics 97
Mathematics, Engineering 101
Mathematics of Investments 102
Mechanical Engineering 82
Mechanical Engineering Laboratory 32
Mechanical Engineering, Laboratory 86
Mechanics, Analytical 75
Mechanics, Applied 75
Mechanics of Solids and Fluids 94
Metallography 66
Metallurgical Collections 27
Metallurgical Laboratory 27
Metallurgical Plant 22, 24
Metallurgical Plant Design 67
Metallurgical Trips 112
Metallurgy 63
Metallurgy of Copper 65
Metallurgy of Gold and Silver 65
Metallurgy of Iron and Steel 64
Metallurgy of Lead 64
Metallurgy of Miscellaneous Metals 66
Metallurgy of Zinc 64
Metal Mining 56, 57

Page
Metals, Research in 66
Microscopic Petrography 70
Mine Accounting 56
Mine Equipment 61
Mine Examinations 59, 62
Mine Fires and Explosions.....109
Mine Management 60
Mine Plant Design 87
Mine Plant Testing..... 87
Mine Power Plant Design..... 86
Mine Power Plants..... 85
Mineral Land Surveying..... 53
Mineral Land Surveying, Field Work..... 53
Mineralological Laboratory 26, 27
Mineralogy 69
Mine Rescue 110
Mine Surveying 54
Mine Surveying, Field Work..... 55
Mine Valuation 59, 62
Mining 53
Mining, Coal 58, 59
Mining, Corporations 58
Mining, Laboratory 31, 54
Mining Law 62
Mining, Metal 56, 57
Mining, Placer 55
Mining Trips 112
Miscellaneous Metals, Metallurgy of..... 66
Modern Languages 107
Museum, Geological and Mineralogical..... 27
Oil, Geology of..... 72
Ore Dressing 64
Ore Dressing Plant..... 22
Ore Treatment Research..... 67
Organization 19
Petrography, Microscopic 70
Physical Laboratories 29
Physical Training 121
Physics 94
Placer Mining 55
Plane and Spherical Trigonometry..... 99
Plane Surveying 74
Plane Trigonometry 98
Power House 22
Power Plants, Mine..... 85
Practical Astronomy 103
Practice of Plane Surveying..... 74
President, Office of 21
President, Residence of 22
Prizes 120
Prospectors' Class 129
Prospectors' Course 113
Pumps 85
Qualitative Analysis 89, 90
Quantitative Analysis 90, 91, 92
Quantitative Analysis, Advanced..... 93
Quarterly 117
Quaternions 103

Page
Radioactivity 95
Registrar, Office of 21
Registration 35
Reports 105
Requirements for Entrance 34
Rescue, Mine 110
Research 26
Research in Fuels, Metals, and Alloys 67
Research in Ore Treatment 67
Reservoirs and Waterways 61
Residence of the President 22
Safety Engineering 109
School Calendar 9
Scientific Society 120
Senior Class 123
Silver, Metallurgy of 65
Simon Guggenheim Hall 21
Social Life 120
Solid Geometry 97
Sophomore Class 125
Spanish 107
Special Lecturers 14
Spherical Trigonometry 98, 99
Standing Committees of the Faculty 13
Steel, Metallurgy of 64
Stratton Hall 22
Structural Details 77
Structural Geology 72
Students, Enrollment of 123
Students' Supplies 116
Support, Financial 20
Surveying Equipment 28
Surveying, Mine 54
Surveying, Mineral Land 53
Surveying, Plane 74
Table of Contents 7
Tabular Views 42
Technical Writing 105
Testing Laboratory 30, 76
Testing Mine Plants 87
Text-books and Students' Supplies 116
Theory of Equations 102
Thesis 39
Trigonometry, Plane 98, 99
Tringonometry, Spherical 98, 99
Trips, Electrical Plant 112
Trips, Inspection 112
Trips, Metallurgical 112
Trips, Mining 112
Trustees 10
Tuition 113
Utah Chapter, Alumni Association 122
United States Bureau of Mines 121
United States Bureau of Mines, Laboratories 32

Page
Valuation of Mines 59, 62
Vector Analysis and Quaternions 103
Writing, Technical 105
Y. M. C. A. 118
Y. M. C. A. Speakers 119
Zinc, Metallurgy of 64

UNIVERSITY OF ILLINOIS-URBANA
3 0112 111486343